

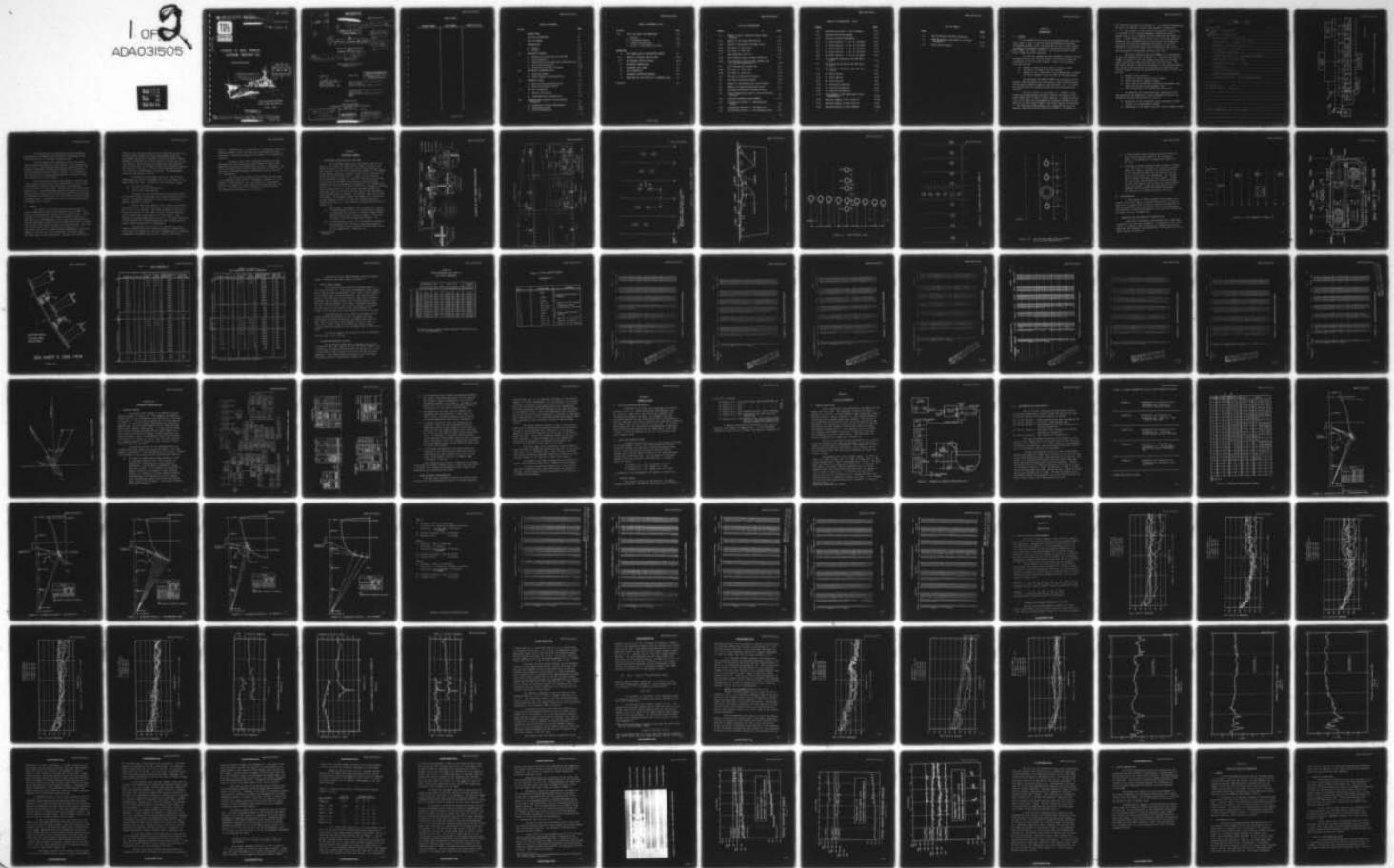
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## PURVIS II SEA TRIALS INTERIM REPORT (U)

(TRG-023-TM-66-32/34)

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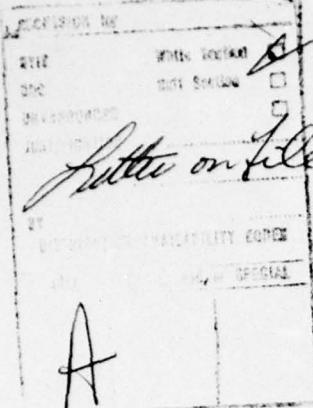
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⑨ Interim Rept. Jun-Jul 66

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PURVIS II SEA TRIALS.

INTERIM REPORT (U)

⑩ Oct 66

⑪

N. Nesenoff, R. Newman ~~and~~ D. Chase

⑫ 274P.

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SECTION I  
INTRODUCTION

A. GENERAL

The PURVIS II Sea Trials were performed during June and July, 1966, as part of the C/P (Conformal/Planar) Array Sonar Development Program, under the direction of the U.S. Navy, Bureau of Ships. The program is managed by the Navy Electronics Laboratory (NEL), San Diego, California, and the David Taylor Model Basin (DTMB) Carderock, Maryland.

*next page*  
The sea test program has been designed to acquire desired information which will provide a basis for critical design considerations on the C/P Array Program. Some of the principal decisions include:

- a) Whether to build an array with or without a dome
- b) The choice of element size and spacing
- c) Whether to use a sonar keel, pod configuration, or mount the array integrally with the ship in the same manner.

The destroyer USS PURVIS (DD709) was instrumented with various sonar hydrophones and electronics, ship's motion sensors, motion picture cameras, magnetic tape recorders, etc., to record the desired data in a medium suitable for data processing and analysis.

The first series of sea trials (i.e., PURVIS I) were conducted during February and March, 1966 in the Tongue of the Ocean (TOTO) area of Andros Island, Bahamas. A complete description of the sonar and instrumentation equipment installed on the ship for the C/P Program PURVIS I Sea Trials appears in Reference 1. The data processing equipment and techniques used for the magnetic tape data recorded during both PURVIS I and PURVIS II

Sea Trials are described in Reference 2. An initial documentation of some of the PURVIS I acoustic data appears in Reference 3.

*cont.* → The purpose of this report is to provide a description of the PURVIS II C/P Program equipment configuration and to present some of the preliminary acoustic data from the PURVIS II tests. A final report will be issued later containing computed parameters such as normalized cross-correlations and normalized cross-spectral densities (amplitude and phase) for selected hydrophone pairs during passive and transmission tests, noise spectra as a function of ship's speed, hydrophone size and location, strut-hydrophone transmission loss data, etc. ←

The basic shipboard system of PURVIS II is illustrated in the block diagram shown in Figure 1-1. The Sea Trial Director (DTMB) is located in the ship's bridge from where he can make visual observations while directing each sea trial "run". The TRG Console Operator supervises operations in the Recording Center. This includes the initiation and termination of operations for various equipment during the preparation and duration of each run, such as:

- a) Magnetic tape recorders
- b) "Fish-eye" stereo motion picture cameras
- c) Bubble generators (Masker system)
- d) Index lamp (to synchronize underwater photographs with tape data during the photographic runs)
- e) Driver-amplifiers and transmitting hydrophones

In addition, the Console-Operator communicates with and supervises the operation of other shipboard facilities (as directed by the Sea Trial Director) such as:

- a) Extension of the retractable strut containing a transmitter, to a predetermined length
- b) Variations in the bubble flow rate from the masker system.

(#2)\* DESTROYERS  
OK-171 17+, 13/10

Descriptors

SEA TESTING

SONAR ARRAYS

DEVELOPMENT TESTS

CONFORMAL STRUCTURES

PLANAR STRUCTURES

ACOUSTIC DATA

HYDROPHONES

CONFIGURATION MANAGEMENT

PASSIVE SYSTEMS

TRANSMISSION LOSS

STRUTS

CAVITATION

RETRACTABLE

UNDERWATER PHOTOGRAPHY

Identifiers

\* DD 709 VESSEL

Mod. abstract p. 1-1, 1-2

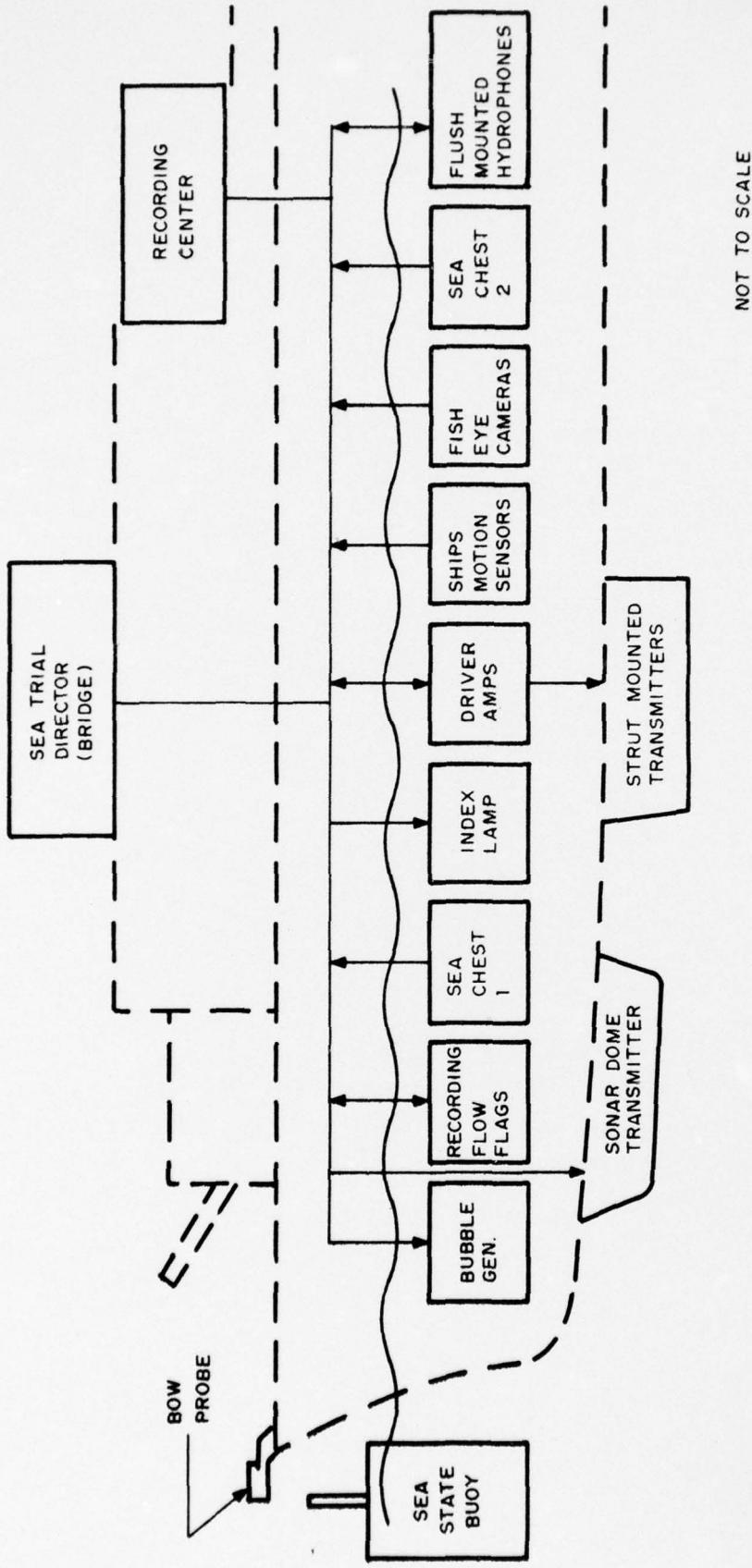


FIGURE 1-1 PURVIS II BASIC SHIPBOARD SYSTEM, BLOCK DIAGRAM

The signals from the hydrophones and accelerometers installed for the PURVIS II Sea Trials are transmitted to the Recording Center for recording on magnetic tape.

The hydrophones were installed in two of the three large Sea Chests previously used in PURVIS I, and flush-mounted in two arrays: High Frequency (HF) and Low Frequency (LF). In addition, individual flush-mounted elements were installed at selected locations between frames 42 and 88. A description of the transducers and instrumentation appears in Sections II and III, respectively, of this report.

Five calibration fixtures were added to the port side of the ship at positions which were approximately at the center (longitudinal) of each of the five groups of hydrophones (i.e., HF array, LF array, etc). During in-situ (overside) calibration tests, a boom containing an acoustic projector (J-9) was placed at each fixture, and the received signals from each group of hydrophones associated with the fixture position were recorded on magnetic tape. A description in the in-situ calibration operation appears in Section V.

#### B. SUMMARY

The PURVIS II Sea Trials were performed during the period commencing on June 22 and ending on July 20, 1966. The runs were chronologically divided into two major series: Naval Architecture and Acoustic. The Naval Architecture Series was also known as the photographic series, since both shipboard and external underwater cameras were used during this series to obtain data on water and bubble flow over the forward portion of the ship for selected ship's speed, heading with respect to sea, etc. Free-divers were used to obtain external photographic data during PURVIS II, and the test area selected was off Bimini Island. The ocean floor in this location was relatively too shallow for

acoustic runs, but was composed of very bright sand, which furnished an ideal background during photographic operations. Photographic operations frequently utilized the masker (bubble generator) system and an air hose placed in the bow wave to produce bubbles. Four recording flow flags and instrumentation were also installed on the ship's motion (low bandwidth) magnetic tape recorder. However, 3 of the 4 flow flags malfunctioned by the 2nd day of photographic operations. The photographic series was concluded on June 25.

The acoustic series began on June 27, when the USS PURVIS departed from Pt. Everglades, Fla. for the Tongue of the Ocean (TOTO) test area. The acoustic tests included 3 types:

- a) Overside calibrations
- b) Passive runs (No transmission)
- c) Active runs (Transmission)

Overside (In-situ) calibrations were performed while the ship was located in the TOTO area, during the period July 6 - July 12. A complete description of the In-Situ calibration operation appears in Section V.

Passive runs were generally 2 or 3 minutes in duration. During these runs, the ship travelled at a speed of either 0, 5, 10, 15, 20, 25, or 30 knots. The ship's heading wrt sea (with respect to sea) was 0°, 90°, 180°, or 270° or was performing a turn by using either full rudder or 1/2 full rudder. Two different recording combinations were used: recording combination 1 which included all forward hydrophones, and recording combination 2, which included all aft hydrophones.

Transmission runs, using 3 or 4 transmitters, also included a passive portion of from 20 seconds to 1 minute prior to the start of transmission, and after transmission was terminated. Transmission frequencies were 1955 Hz, 2125 Hz, 2465 Hz and

2975 Hz. Transmitter No. 2, which was on a retractable strut, was usually extended 5 feet, with some runs occurring with shorter extensions. Transmission periods were usually 2 to 4 minutes in duration.

During the first week's operation, analysis of data indicated that the transmitting strut located at frame 58 was apparently cavitating at speeds above 20 knots. Accordingly, the strut was removed from the ship during the period between July 2 and July 5, limiting subsequent transmission tests to the use of 3 transmitters.

The final week of PURVIS II Sea Trials took the ship on a northbound course from Pt. Everglades to Newport, R.I., in search of "rough weather" (i.e., sea states of 3 and higher). However, the highest sea state encountered during the data run was "2". The last data run was recorded on July 20 and the USS PURVIS entered Newport, R.I. on July 21.

## SECTION II

### TRANSDUCER SUMMARY

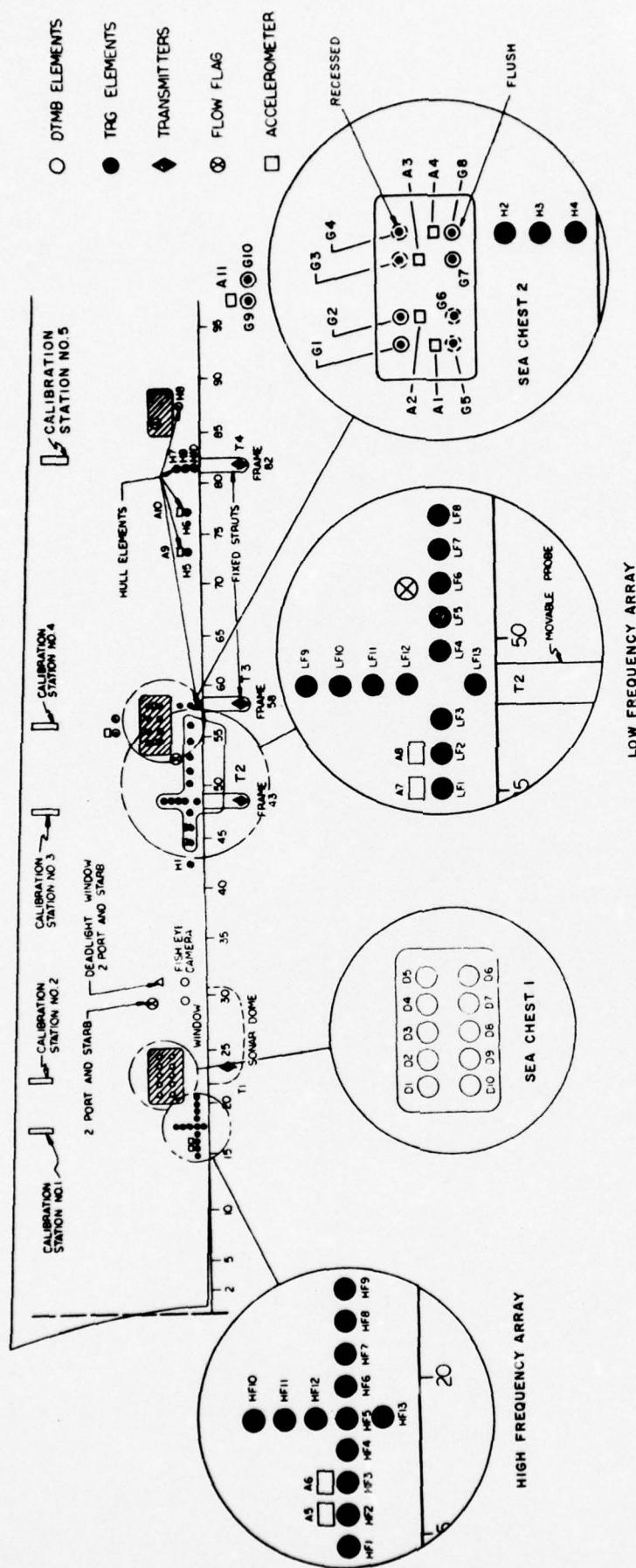
#### A. HYDROPHONE DESCRIPTION AND LOCATIONS

The Conformal/Planar Sonar installation used for the PURVIS II Sea Trials is illustrated in Figures 2-1a and 2-1b. During the month of May, 1966, in a Boston Naval Shipyard dry dock, the port side of the USS PURVIS was modified by the removal of all PURVIS I acoustic receivers located in the 3 special sea chests and selected hull areas.\* As part of the C/P Array Sonar Development Program, the ship was retrofitted with 46 TRG 5" receivers and 10 DTMB FS-13 receivers, along with other special sonar and instrumentation equipments. The 10 DTMB hydrophones were installed in a special window made by GD/EB, containing various thicknesses of a visco elastic material between the fiber glass face of the window and the face of each hydrophone. Each hydrophone had two outputs: an acoustic signal and a vibration signal. The acoustic signal from element D1 is identified in this document as D1H, etc., and the vibration signal is identified as D1A, etc. The window was installed in Sea Chest 1. (Figure 2-2).

- The 46 TRG 5" hydrophones were installed in 4 groups:
- a) A "high frequency array" of 13 flush-mounted elements, 9 horizontal and 5 vertical (1 common), spaced approximately 10-1/2" apart, center-to-center, in the area of frames 15-20 (HF1 through HF13) (Figure 2-3).
  - b) A "low-frequency array" of 13 flush-mounted elements, 8 horizontals and 5 verticals spaced approximately 31-1/2" apart, center-to-center, between frames 48-60. (LF-1 through LF-13) (Figure 2-4).

---

\* Reference 1



PURVIS II C/P SONAR INSTALLATION

FIGURE 2-1a.

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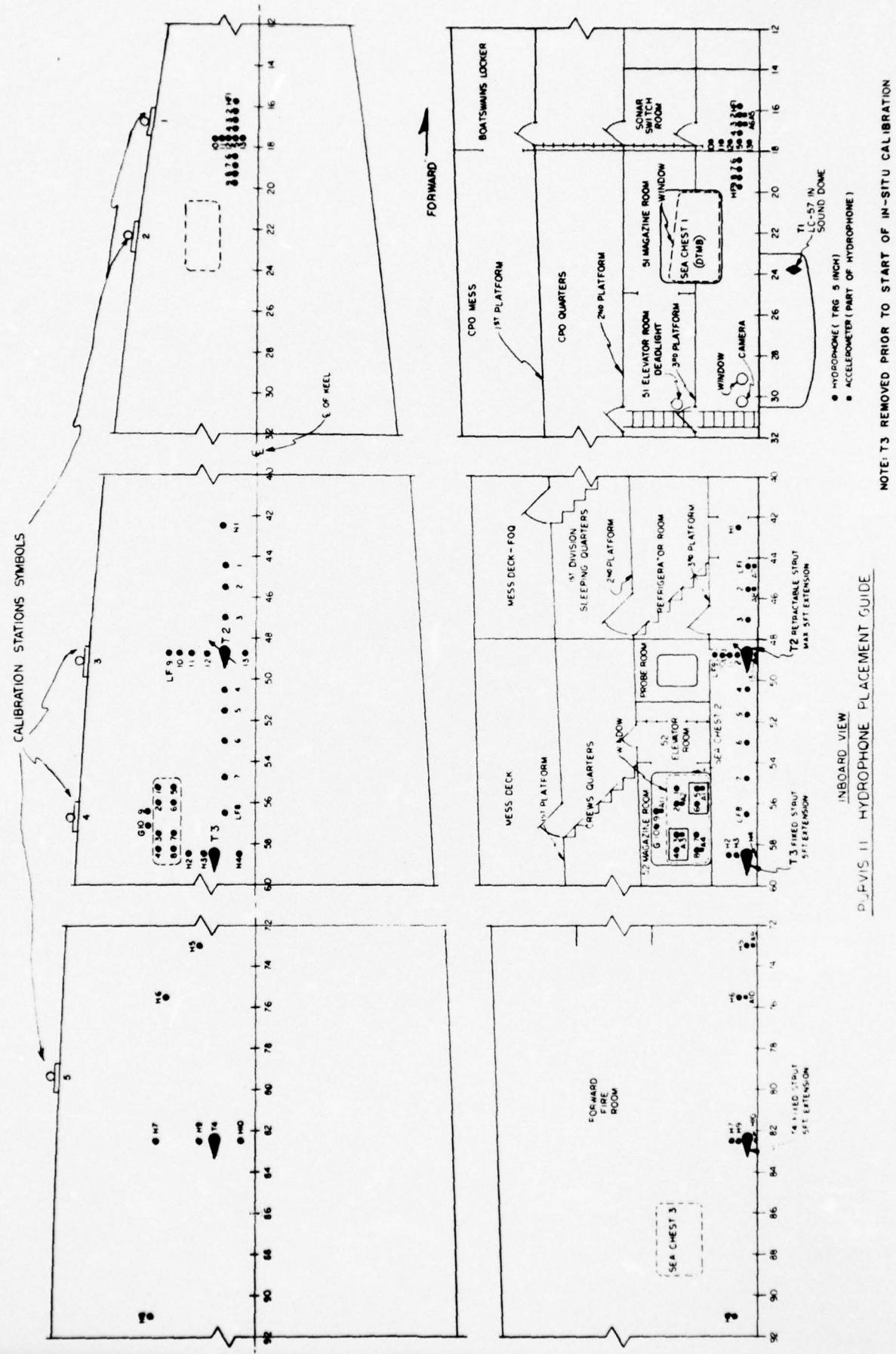


FIGURE 2-1b.

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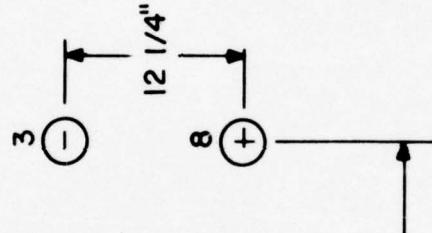
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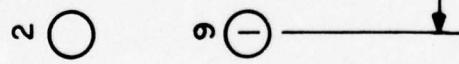
24



23



22



21



FRAME  
NO.

NOTE:

HORIZONTAL AND VERTICAL DISTANCES  
BETWEEN ELEMENTS ARE EQUAL.

FIGURE 2-2a. SEA CHEST 1 FRONT VIEW

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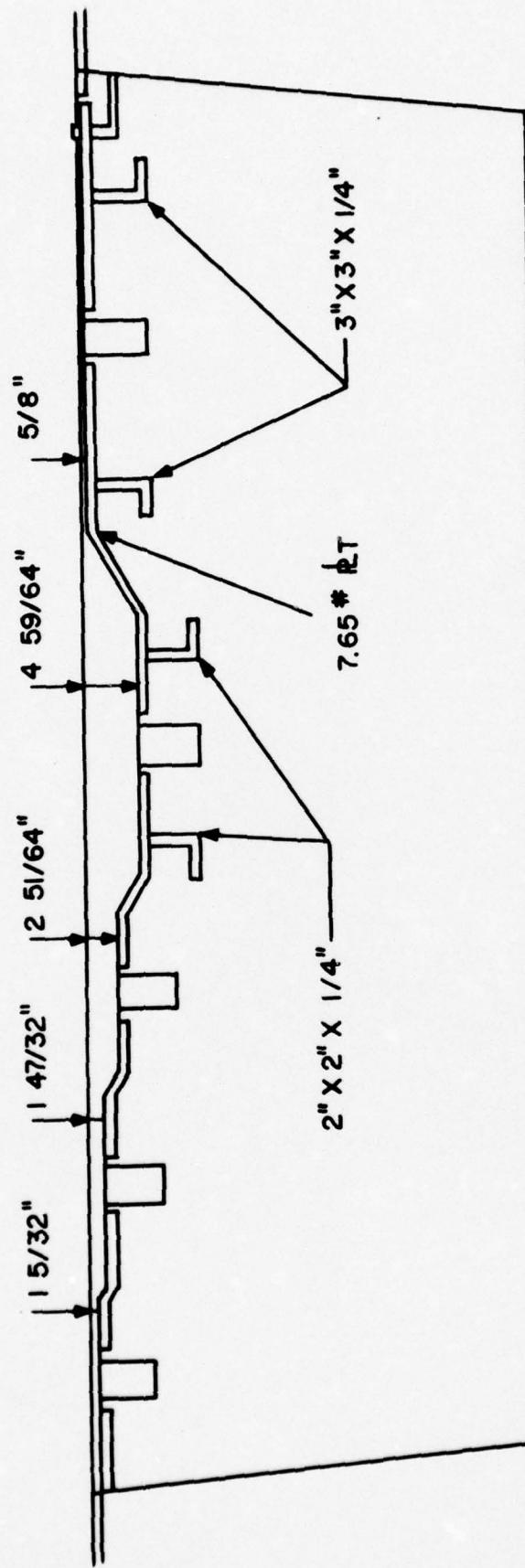


FIGURE 2-2b. SEA CHEST 1, SIDE VIEW

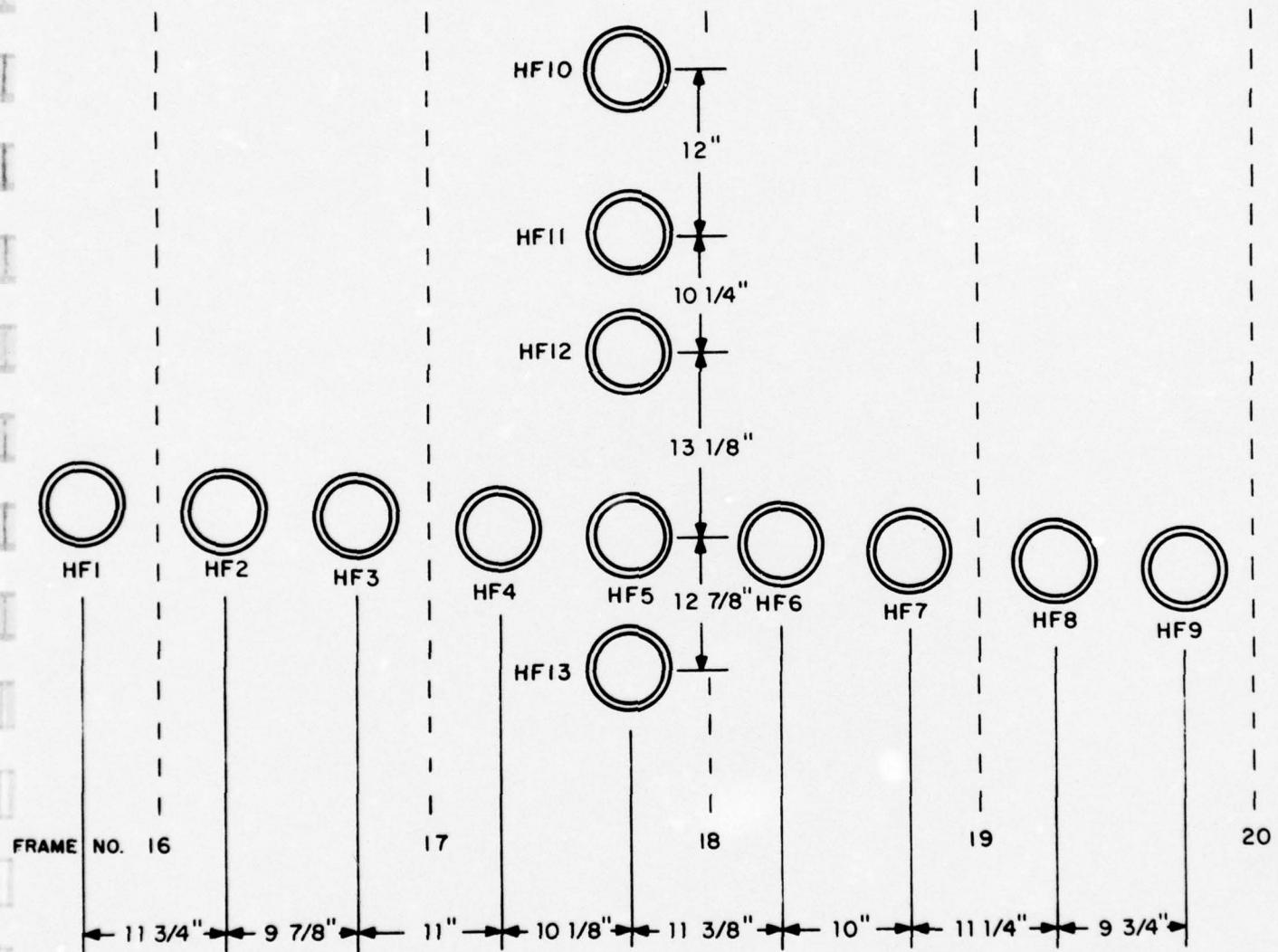


FIGURE 2-3. HIGH FREQUENCY ARRAY

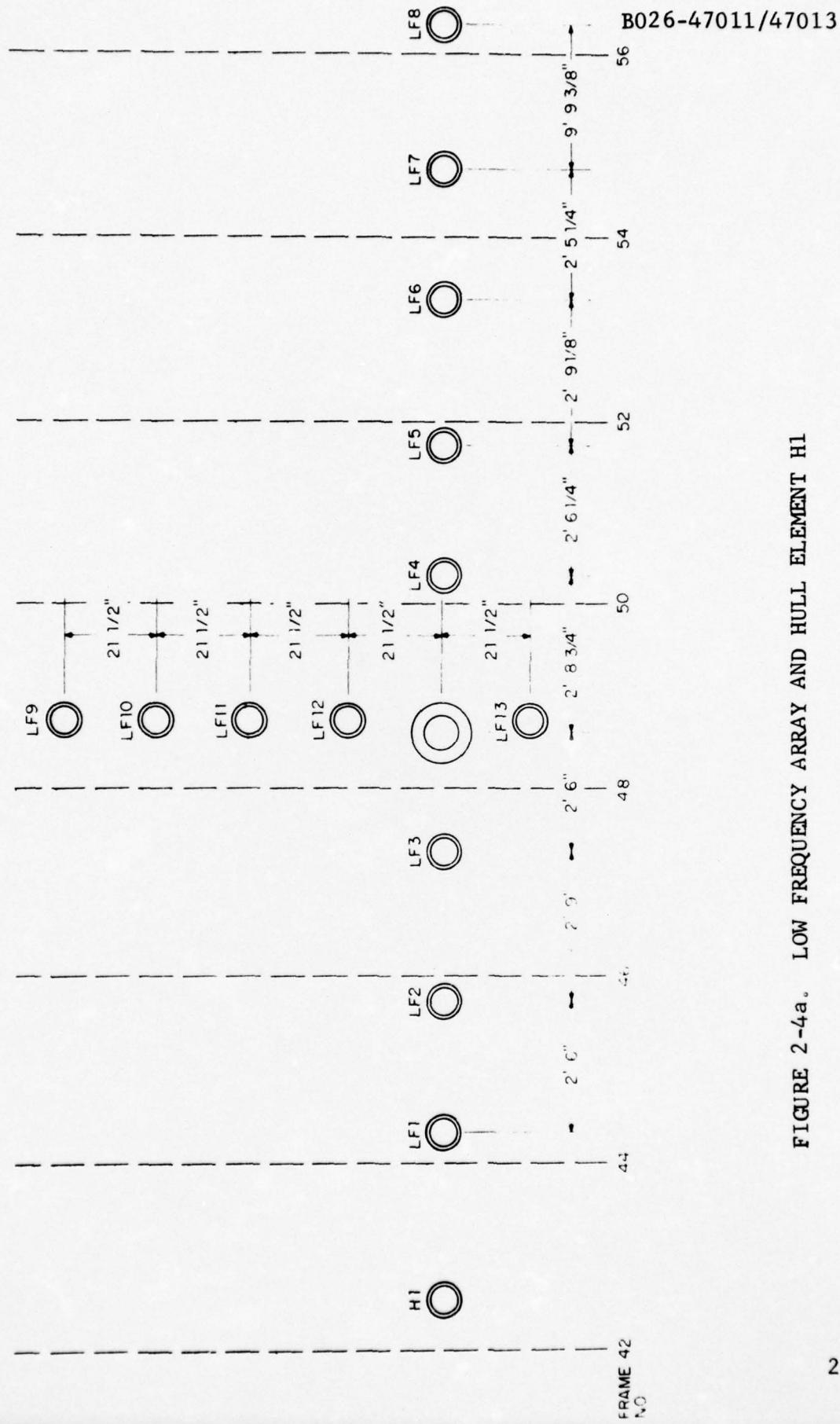


FIGURE 2-4a. LOW FREQUENCY ARRAY AND HULL ELEMENT H1

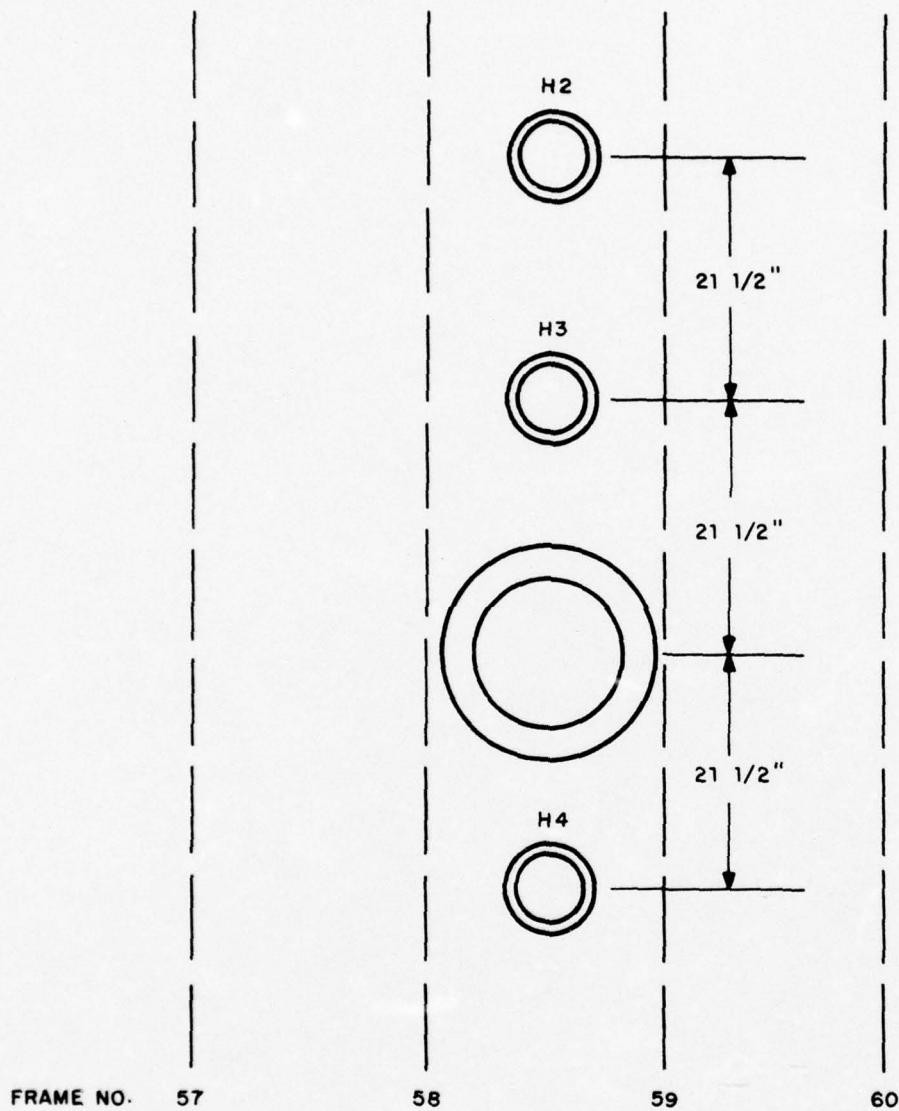


FIGURE 2-4b. LOW FREQUENCY ARRAY AND HULL ELEMENTS  
H2, H3, H4 AND TRANSMITTER T3

- c) 10 flush-mounted single elements located near the two fixed struts and near frames 42, 58, and between frames 72 through 88 (H-1 through H-10) (Figure 2-4 and 2-5).
- d) 10 elements located within and near Sea Chest 2 (Figure 2-6). Of these 8 are mounted on a special fiberglass window in 4 pairs: two pairs are flush-mounted (G1, G2, G7, G8) and the other two are recessed from the water by a 6" cavity, (G3 through G6). The cavities can be flooded with water and also drained. During the sea trials, the cavities were filled with water. The last two elements (G9 and G10) were flush-mounted above the window. A dome was placed around all 10 elements which also could be flooded and drained. The dome was not flooded during the sea trials.

#### B. ACCELEROMETERS

At the request of DTMB a miniature accelerometer was mounted on the rear masses of selected TRG receivers located in each of the 4 groups above in order to measure the magnitude of vibration appearing along the sensitive axis of the hydrophone. The locations of these accelerometers (11 in all) are illustrated in Figure 2-1a (A-1 through A-11).

#### C. TRANSDUCER AND PRE-AMPLIFIER IDENTIFICATION

Each TRG 5" hydrophone, accelerometer and preamplifier installed on the ship was serialized. A tabulation of the serial numbers vs. element, their associated SCA (Signal Conditioning Amplifier) and connector identification in the Shipboard Recording Center appears in Table 2-1.

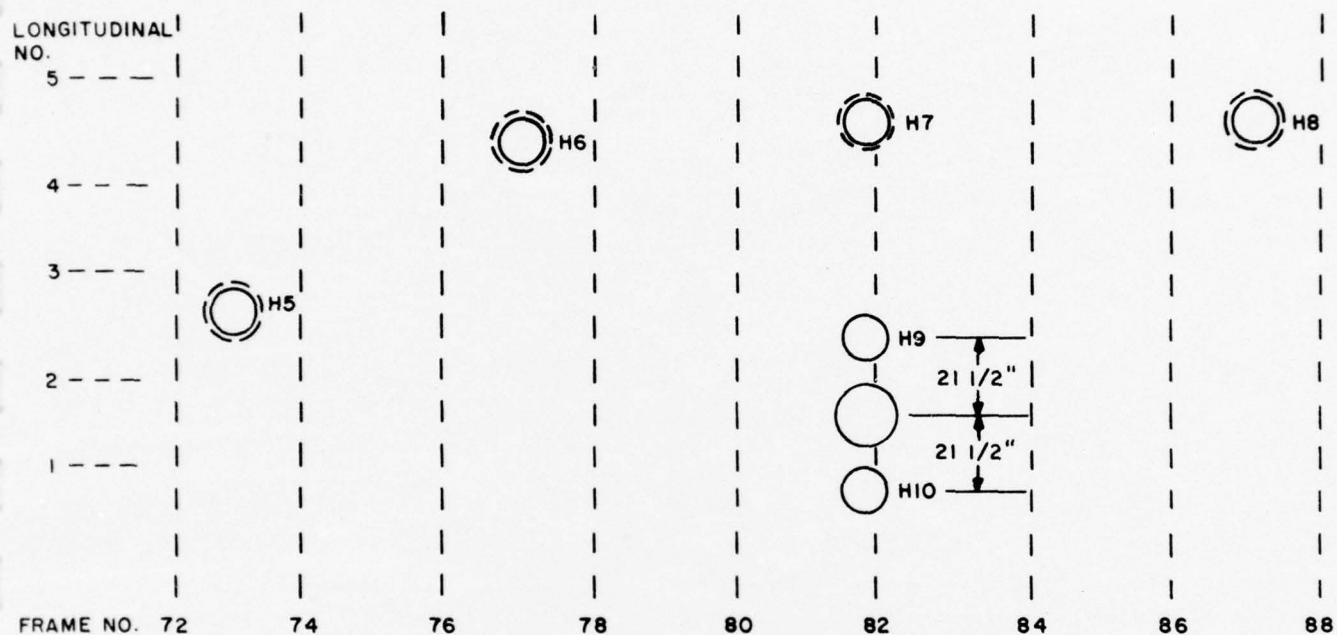
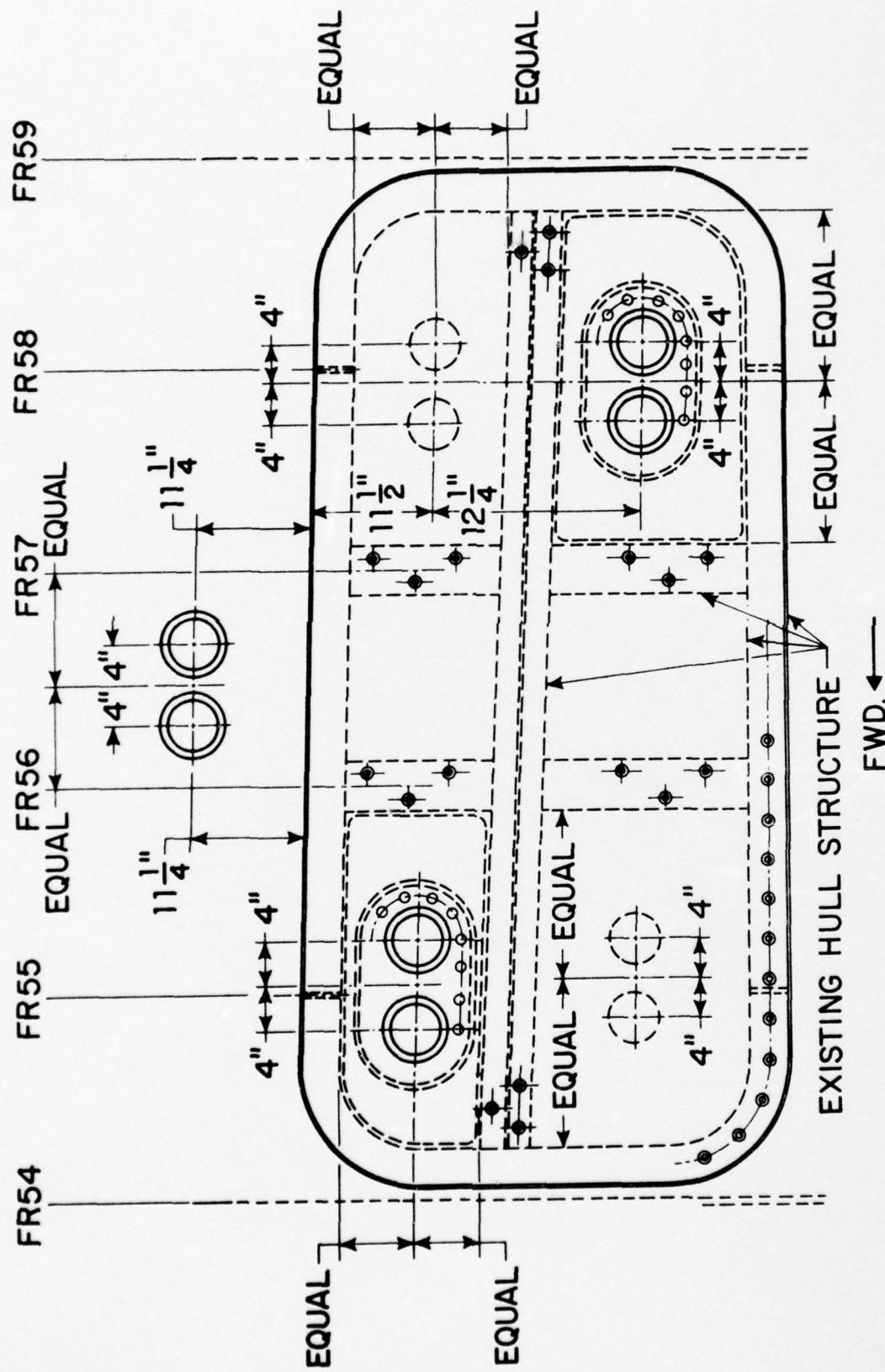
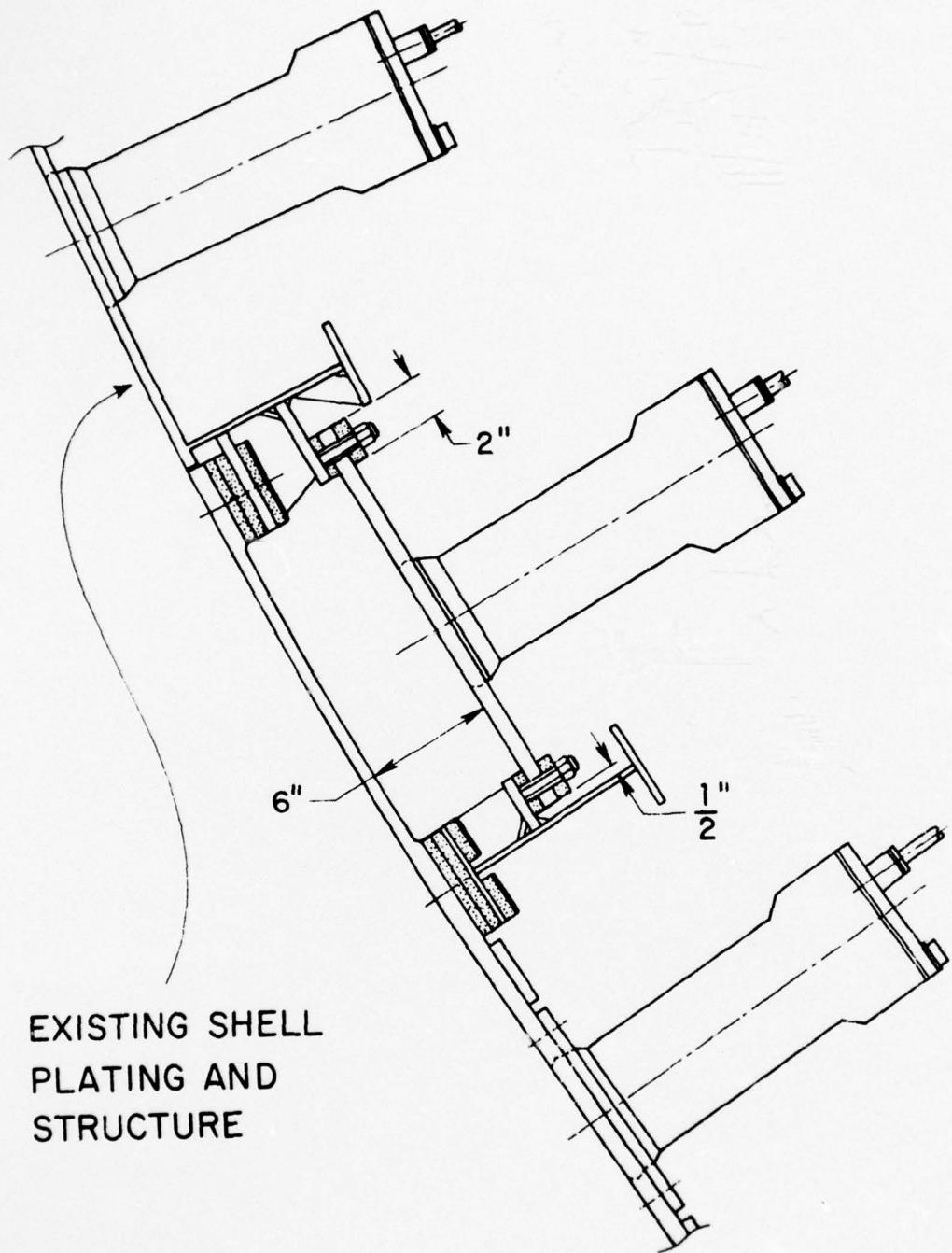


FIGURE 2-5. HULL ELEMENTS H5 THROUGH H10



SEA CHEST 2 - FRONT VIEW

FIGURE 2-6a



SEA CHEST 2 - SIDE VIEW

FIGURE 2-6b

2-9a

TABLE 2-1. TRG TRANSDUCERS AND CABLE CONNECTORS

ELEMENT NO.	SCA NO.	B + CAL. CONN.	SIG. CONN.	HYDROPHONE/ACC. SERIAL NO.	PRE-AMP. SER. NO.
CALIBRATION STATION 1	HF 1	1	1-1-1	P1007	110
	HF 2	2	1-1-2	P1011	117
	HF 3	3	1-1-3	P1076	253
	HF 4	4	" 4	P1036	121
	HF 5	5	" 5	P1027	146
	HF 6	6	" 6	P1019	125
	HF 7	7	" 7	P1030	136
	HF 8	8	" 8	P1002	112
	HF 9	9	" 9	P1014	130
	HF 10	10	" 10	P1060	137
	HF 11	11	" 11	P1031	149
	HF 12	12	" 12	P1004	103
	HF 13	13	" 13	P1008	122
CALIBRATION STATION 2	A 5	14	" 14	1001	256
	A 6	15	" 15	1002	160
CALIBRATION STATION 3	LF 1	16	2-1-1	P1015	111
	LF 2	17	2-1-2	P1034	259
	LF 3	18	2-1-3	P1010	120
	LF 4	19	" 4	P1001	127
	LF 5	20	" 5	P1043	113
	LF 6	21	" 6	P1063	106
	LF 7	22	" 7	P1029	150
	LF 8	23	" 8	P1059	118
	LF 9	24	" 9	P1068	142
	LF 10	25	" 10	P1012	123
	LF 11	26	" 11	P1062	107
	LF 12	27	" 12	P1050	102
	LF 13	12	" 12	P1065	134
CALIBRATION STATION 4	A 7	29	" 14	996	116
	A 8	30	" 15	1003	258

TABLE 2-1 (cont'd)  
TRG TRANSDUCERS AND CABLE CONNECTORS

ELEMENT NO.	SCA NO.	B + CAL. CONN.	SIG. CONN.	HYDROPHONE/ACC. SERIAL NO.	PRE-AMP. SER. NO.
CALIBRATION STATION 4	G 1	31	2-3-1	P1095	144
	G 2	32	2-3-2	P1073	135
	G 3	33	" 3	P1021	131
	G 4	34	" 4	P1098	152
	G 5	35	" 5	P1020	141
	G 6	36	" 6	P1042	145
	G 7	37	" 7	P1045	156
	G 8	38	" 8	P1071	143
	G 9	39	" 9	P1079	155
	G 10	40	" 10	P1052	133
CALIBRATION STATION 3	A 2	41	" 11	994	153
	A 3	42	" 12	993	132
	A 1	43	" 13	999	151
	A 4	44	" 14	995	164
	A 11	45	" 15	992	140
CALIBRATION STATION 5	*H 1	46	2-5-9	P1075	105
	H 2	47	2-5-10	P1051	148
	H 3	48	2-5-11	P1078	126
	H 4	49	2-5-12	P1057	159
CALIBRATION STATION 3	H 5	50	3-1-5	P1046	158
	H 6	51	3-1-6	P1061	255
	H 7	52	" 7	P1056	251
	H 8	53	" 8	P1016	139
	H 9	54	" 9	P1009	114
	H 10	55	" 10	P1049	129
	A 9	56	" 11	997	147
	A 11	57	" 12	1000	168

\* H 1 is located near calibration Station 3

A tabulation of the DTMB hydrophone and accelerometer outputs, connectors and SCAs, appears in Table 2-2.

#### D. SHIP'S MOTION SENSORS

The 12 ship's motion sensors used during PURVIS II are listed in Table 2-3. The three accelerometers (Sway, Surge, Heave) and the three potentiometers (Yaw, Pitch, Roll) originate at the Stable Table (inertial platform). The sea state buoy, which is cast overboard on days when sea state data is desired, transmits the sea state signal to the recording center via a UHF radio link at 138 MHz. This device, nicknamed "Splashnik" contains an accelerometer that is used to measure wave height. The bow probe is an ultrasonic device which measures the height of the bow above the water during the course of the runs.

The modifications to the ship for the PURVIS II Sea Trials included the addition of four recording flow flags manufactured by GD/EB and modified, per DTMB instructions, by TRG. Three of the flags were installed on the port side at frame 29-1/2 (FFA), frame 52-1/2 (FFB) and frame 86 (FFC). A fourth flag was installed on the starboard side at frame 29-1/2 (FFD).

All twelve signals were recorded on the low bandwidth recorder (No. 5) at 1-7/8 ips.

#### E. TRANSMITTER-RECEIVER DISTANCES

The distances between each 5" receiver and the four transmitters have been computed and are tabulated in Figure 2-7. In addition, the angles associated with the distance R to T and a line normal to the transducer front face (N) have also been tabulated. These angles have been measured in the C/P Sonar Coordinate System as illustrated in Figure 2-8.

TABLE 2-2  
DTMB HYDROPHONES (SEA CHEST 1)  
AND CABLE CONNECTORS

Hydrophone (H)			Accel. (A)		Vibrator Input
Connector	SCA No.*		Connector	SCA No.	Connector
D1	1-4-1	60	1-3-1	75	1-5-1
D2	1-4-2	61	1-3-2	76	1-5-2
D3	1-4-3	62	1-3-3	77	1-5-3
D4	1-4-4	63	1-3-4	78	1-5-4
D5	1-4-5	64	1-3-5	79	1-5-5
D6	1-4-6	65	1-3-6	80	1-5-6
D7	1-4-7	66	1-3-7	81	1-5-7
D8	1-4-8	67	1-3-8	82	1-5-8
D9	1-4-9	68	1-3-9	83	1-5-9
D10	1-4-10	69	1-3-10	84	1-5-10

Calibration Station →  
 2

\*To SCA via dual channel summing amplifier modified for use  
as a 20 DB preamplifier

## TABLE 2-3 SHIP'S MOTION SENSORS

RECORDER NO. 5

Track	Signal Name	Comments
1	Sway	
2	Surge	{ Stable Table Accelerometers.
3	Heave	
4	F.F. "A"	Near Fr. 29 1/2 (port)
5	Bow Probe	Ultrasonic device
6	S.S. Buoy	Transmitted at 138 MHz
9	Pitch	
10	Roll	{ Stable Table Potentiometers
11	Yaw	
12	F.F. "B"	Near Fr. 52 1/2 (port)
13	F.F. "C"	Near Fr. 86 (port)
14	F.F. "D"	Near Fr. 29 1/2 (stbd.)

## XI TRANSMITTER IN SONAR ECCR

TRANSMITTER	RECEIVER	ROUTING LENGTH	ROUTER	ROUTER	ROUTER	ROUTER	ROUTER	ANGLE-IN 1C RT
X1								
MF1		16'	6.22200	-22.374	178.928	-32.000	273.CC7	61.258
MF2		13'	7.47000	-24.581	178.844	-33.000	274.733	79.931
MF3		12'	5.54200	-26.287	178.647	-33.000	272.733	75.185
MF4		11'	11.77100	-28.228	178.441	-34.000	272.733	71.566
MF5		11'	3.05400	-10.232	178.156	-35.000	272.733	76.565
MF6		10'	5.70200	-12.749	177.564	-35.000	273.001	75.825
MF7	S1	9.44400	-35.380	177.477	-36.000	273.001	74.254	
MF8	S1	9.71300	-38.719	176.113	-37.000	273.001	72.444	
MF9	H1	5.87800	-41.872	175.464	-38.500	273.CC7	70.184	
LF10		12'	1C.61800	-4C.115	170.504	-19.500	275.232	86.245
PF11		12'	3.C9400	-16.928	172.671	-25.000	274.517	83.562
PF12		11'	9.28700	-34.058	175.099	-78.000	273.750	81.226
HF13	1C	9.87100	-26.034	181.964	-4C.000	272.C13	73.648	
LF1	36'	11.81100	-6.972	1.512	-65.500	272.267	82.245	
LF2	39'	5.57300	-6.487	1.522	-65.500	272.267	82.251	
LF3	41'	11.46200	-6.172	1.489	-68.000	271.583	84.654	
LF4	47'	4.69200	-5.215	1.353	-69.500	272.505	86.064	
LF5	49'	1C.48800	-5.077	1.335	-70.500	272.005	84.982	
LF6	52'	7.76300	-4.912	1.297	-71.500	272.300	85.119	
LF7	55'	1.66500	-4.405	1.234	-72.500	272.300	85.289	
LF8	57'	10.48700	-4.294	1.244	-72.500	272.CC5	85.675	
LF9	55	7.47500	-11.562	2.013	-39.500	272.267	88.1C3	
LF10	45	2.41200	-9.551	7.452	-47.000	274.861	84.718	
LF11	44'	1C.23000	-8.010	5.664	-55.000	274.983	83.636	
LF12	44'	7.08700	-6.078	1.661	-62.500	273.750	83.984	
LF13	44'	4.45900	-4.947	1.915	-72.000	272.005	84.761	
G1	57'	0.02400	-11.134	6.436	-26.500	272.450	87.253	
G2	52'	1.77000	-11.055	6.327	-28.500	276.450	87.258	
C1	61'	5.75000	-10.347	6.164	-28.500	276.450	87.482	
G4	63'	1.22400	-1C.141	5.666	-28.500	276.450	87.448	
G5	56'	5.44400	-9.460	2.336	-38.000	276.333	81.662	
G6	57'	1.52100	-9.350	2.359	-38.000	276.333	81.JC7	
G7	62'	1.58900	-8.551	6.655	-38.500	276.450	87.460	
G8	62'	9.46600	-8.492	8.*CC	-19.000	276.400	86.518	
G9	63'	4.73600	-12.768	11.399	-24.000	276.450	85.486	
G10	51'	0.40400	-12.778	11.273	-23.500	276.450	85.539	
H1	35'	11.17300	-8.647	1.168	-63.500	272.850	82.459	
H2	62'	5.47700	-6.554	4.452	-64.000	275.933	83.185	
H3	61'	3.32500	-5.167	6.946	-69.000	274.567	84.476	
H4	61'	5.22400	-2.542	7.457	-78.000	27C.9CC	86.2C1	
H5	1.717	1.67200	-2.574	6.444	-76.500	273.350	86.457	
H6	95'	1.19200	-2.314	4.177	-65.000	270.717	88.237	
H7	1C.41	7.10600	-3.533	4.387	-71.000	274.767	88.724	
H8	114'	7.45700	-2.677	4.144	-71.000	274.323	87.799	
H9	114'	4.16700	-2.113	1.496	-78.500	272.817	87.5C1	
H10	114'	3.19400	-2.114	4.734	-8C.000	270.417	87.5E45	

COPY AVAILABLE TO DDC DOES NOT  
PERMIT FULLY LEGIBLE PRODUCTION

FIGURE 2-7. TRANSMITTER-RECEIVER DISTANCES

## X3 FIXED STRUT AT FRAME 56

8/19/66 FACT

TRANSMITTER	RECEIVER	RECTIFY LENGTH	PHI-X	PHI-Y	PHI-Z	ANGLE-N IC RT
X3						
HF1		15° 4.969"	-5.231	181.812	-32.000	272.007
HF2		14° 5.275"	-5.299	181.836	-33.000	272.733
HF3		13° 6.320"	-5.365	181.843	-33.000	272.733
HF4		12° 7.266"	-5.432	181.850	-34.000	272.733
HF5		11° 9.409"	-5.496	181.855	-35.000	272.733
HF6		7C 10.442"	-5.567	181.868	-35.000	273.007
HF7		7C 0.479"	-5.633	181.881	-36.000	273.007
HF8		69° 1.515"	-5.708	181.886	-37.000	273.007
HF9		68° 4.556"	-5.770	181.795	-38.500	272.007
HF10		72° 0.642"	-7.525	180.802	-19.500	275.333
HF11		71° 11.310"	-6.644	181.102	-25.000	274.517
HF12		71° 10.367"	-6.233	181.437	-24.000	274.517
HF13		71° 8.710"	-6.765	182.372	-40.000	272.013
LF1		25° 8.334"	-12.412	183.790	-65.500	272.267
LF2		23° 3.079"	-14.104	184.025	-65.200	272.267
LF3		2C 10.303"	-15.512	184.408	-63.000	271.982
LF4		15° 7.060"	-20.742	185.947	-69.500	272.005
LF5		13° 4.037"	-24.947	187.076	-70.500	272.005
LF6		1C 11.053"	-31.001	188.333	-71.500	272.300
LF7		C 12.519"	-35.334	189.022	-72.000	272.300
LF8		6° 11.657"	-52.647	189.970	-72.500	272.005
LF9		2C 7.285"	-29.892	165.932	-39.500	272.267
LF10		15° 9.602"	-26.052	169.776	-47.000	274.867
LF11		14° 1.257"	-22.979	174.256	-55.000	274.983
LF12		1P 7.679"	-26.126	179.463	-62.500	273.750
LF13		1E 6.096"	-15.908	190.521	-72.000	270.767
G1		1A 2.776"	-53.607	132.363	-28.500	276.450
G2		1A 11.721"	-50.282	125.054	-28.500	276.450
G3		1A 3.486"	-59.518	97.943	-28.500	276.450
G4		1A 3.111"	-59.792	92.663	-28.500	276.450
G5		1A 1.323"	-60.017	133.355	-38.000	276.332
G6		1A 6.557"	-62.818	163.770	-38.000	276.333
G7		12° 6.875"	-56.457	8.276	-38.500	276.400
G8		12° 6.520"	-56.772	92.776	-39.000	276.400
G9		11° 4.405"	-54.511	112.975	-24.000	276.450
G10		1C 11.363"	-55.576	105.302	-23.500	276.450
H1		2C 0.373"	-11.346	182.757	-63.500	272.850
H2		1C 11.115"	-75.453	90.000	-64.000	275.933
H3		6.535"	-64.550	90.000	-69.000	274.567
H4		5° 11.405"	-57.729	270.000	-70.000	276.400
H5		2C 1C 4.744"	-12.772	2.457	-16.500	273.350
H6		43° 16.577"	-11.121	7.410	-6.000	270.717
H7		44° 9.511"	-9.790	7.267	-71.000	274.767
H8		51° 2.641"	-7.000	7.250	-73.000	274.332
H9		41° 1C 0.655"	-7.500	1.C03	-70.500	272.817
H10		41° 1C 0.754"	-6.702	45° 7.72	-7C.000	270.417

COPY AVAILABLE TO DDC DOES NOT  
PERMIT FULLY LEGIBLE PRODUCTION

FIGURE 2-7a. TRANSMITTER-RECEIVER DISTANCES

## X2A RETRACTABLE STRUT EXTENDED 1 FCCF

E/15/66 FFCF

TRANSMITTER	RECEIVER	R TO T LENGTH	T-TA-RT	P+T-KI	T-F1A-A	P1-A	ANGLE-A TC RT
X2A							
HF1	57 7.383"	-22.114	161.244	-31.4.CCC	273.0.CC7	SC.374	
HF2	56 7.644"	-21.150	181.246	-33.4.000	272.732	SC.655	
HF3	55 8.645"	-21.166	181.265	-33.4.000	272.732	SC.CC0	
HF4	54 9.655"	-22.267	181.264	-34.4.CCC	272.732	SC.714	
HF5	53 11.659"	-22.256	181.262	-35.4.CCC	272.732	SC.510	
HF6	52 0.654"	-22.245	181.216	-35.4.CCC	273.0.CC7	SC.149	
HF7	52 2.654"	-22.312	181.150	-36.4.000	273.0.CC7	SC.654	
HF8	51 3.650"	-22.374	161.141	-37.4.CCC	273.0.CC7	QC.CC0	
HF9	50 6.655"	-22.409	181.134	-38.4.CCC	273.0.CC7	85.465	
HF10	54 1.510"	-24.040	179.867	-19.500	275.333	93.445	
HF11	54 C.651"	-25.056	180.266	-25.4.CCC	274.517	92.126	
HF12	54 C.085"	-3.240	180.276	-28.4.CCC	273.720	91.160	
HF13	53 11.536"	-1.283	181.947	-40.4.CCC	272.013	E5.225	
LF1	70 6.94.CC	-7.166	164.052	-65.500	272.267	E2.725	
LF2	59 1.247"	-10.346	185.237	-67.500	272.267	79.264	
LF3	28 5.262"	-22.918	166.462	-68.4.CCC	271.463	62.512	
LF4	30 1.456"	-14.657	152.675	-69.5.CCC	272.003	73.363	
LF5	45 6.573"	-6.620	156.2C7	-70.500	272.005	75.507	
LF6	45 1.066"	-6.676	157.831	-71.4.CCC	272.300	82.844	
LF7	1C 9.491"	-9.107	158.335	-72.5.CCC	272.300	84.320	
LF8	13 6.307"	-3.476	158.439	-72.5.CCC	272.005	E5.078	
LF9	7 6.986"	-43.3.066	9C.0CC	-79.500	272.267	57.009	
LF10	21 5.561"	-42.756	9C.0CC	-87.4.CCC	274.867	9C.141	
LF11	31 11.456"	-43.187	9C.0CC	-85.4.CCC	274.963	81.122	
LF12	27 1.227"	-42.449	9C.0CC	-87.4.CCC	273.770	65.413	
LF13	21 6.791"	-14.441	9C.0CC	-74.0.CCC	27C.767	E3.264	
G1	1C 5.170"	-23.065	34.0.C73	-78.4.CCC	276.450	97.521	
G2	1C 3.676"	-2.673	32.586	-28.5.CCC	276.450	96.529	
G3	1C 11.505"	-22.296	26.691	-28.5.CCC	276.450	95.446	
G4	2C 6.16.C	-21.665	25.781	-24.5.CCC	276.450	95.446	
G5	1C 0.664"	-25.255	3.849	-18.4.CCC	276.333	72.154	
G6	1C 5.244"	-25.250	3.038	-14.4.CCC	276.333	72.154	
G7	1C 2.535"	-17.361	25.865	-74.5.CCC	276.450	63.629	
G8	1C 6.442"	-10.401	14.584	-15.4.CCC	276.450	92.146	
G9	1C 4.477"	-23.4.036	36.6.646	-24.4.CCC	276.450	1G2.735	
G10	1C 10.18.0"	-47.708	25.342	-23.4.000	273.350	101.543	
F1	1C 5.251"	-6.487	161.236	-62.500	272.897	F4.516	
F2	1C 2.786"	-12.372	10.880	-64.000	275.933	8G.962	
F3	1C 3.229"	-6.488	5.0.CCS	-69.000	274.267	84.411	
F4	1C 7.960"	-5.524	15.2.316	-76.000	270.600	87.594	
F5	1C 3.110"	-1.310	2.4.957	-76.300	273.350	FE.674	
F6	5C 5.658"	-27.620	6.122	-69.0.CCC	27C.717	9C.047	
F7	5C 3.791"	-22.362	6.267	-71.4.CCC	274.767	8G.216	
F8	7C 4.175"	-11.474	5.0.675	-73.0.CCC	274.321	8G.564	
F9	5C 3.451"	-1.475	1.0.611	-79.4.CCC	272.617	8S.126	
F10	4C 3.011"	-1.475	1.0.611	-85.0.CCC	27C.417	85.425	

COPY AVAILABLE TO DDC DOES NOT  
PERMIT FULLY LEGIBLE PRODUCTION

FIGURE 2-7b. TRANSMITTER-RECEIVER DISTANCES

## A2: RETRACTABLE STILT EXTENDED 2 FEET

TRANSMITTER	RECEIVER	R TO T LENGTH	REFL-R	REFL-T	REFL-A	ANGLE-N W. E
RF1	RF1	57'	6.000"	-3.000	161.578	222.000
RF2	RF2	56'	-2.273"	161.604	272.733	85.245
RF3	RF3	55'	9.247"	161.620	272.713	85.217
RF4	RF4	54'	15.360"	161.643	272.673	85.126
RF5	RF5	53'	20.314"	161.663	272.733	85.030
RF6	RF6	52'	1.316"	161.676	272.663	85.176
RF7	RF7	51'	1.721"	161.687	272.663	85.112
RF8	RF8	50'	4.374"	161.514	213.000	85.142
RF9	RF9	49'	7.035"	161.519	271.000	85.054
RF10	RF10	48'	4.618"	161.521	271.000	85.076
RF11	RF11	47'	1.577"	161.521	271.000	85.317
RF12	RF12	46'	0.892"	161.563	273.750	85.371
RF13	RF13	45'	0.044"	162.301	272.000	85.207
RF14	RF14	44'	5.437"	165.578	272.267	75.346
RF15	RF15	43'	4.746"	166.597	272.267	66.800
RF16	RF16	42'	3.645"	156.654	271.962	51.150
RF17	RF17	41'	2.933"	146.527	272.000	57.348
RF18	RF18	40'	6.432"	146.527	272.000	65.700
RF19	RF19	39'	1C.C720"	161.763	272.000	75.410
RF20	RF20	38'	6.711"	162.441	272.300	75.410
RF21	RF21	37'	11.112"	162.710	272.300	75.410
RF22	RF22	36'	16.654"	162.710	272.300	75.410
RF23	RF23	35'	29.330"	162.710	272.300	75.410
RF24	RF24	34'	6.432"	162.710	272.300	75.410
RF25	RF25	33'	1.712"	162.710	272.300	75.410
RF26	RF26	32'	-1.471"	162.710	272.300	75.410
RF27	RF27	31'	-12.443"	162.710	272.300	75.410
RF28	RF28	30'	-2.710"	162.710	272.300	75.410
RF29	RF29	29'	-7.710"	162.710	272.300	75.410
RF30	RF30	28'	-19.330"	162.710	272.300	75.410
RF31	RF31	27'	-1.712"	162.710	272.300	75.410
RF32	RF32	26'	4.661"	162.710	272.300	75.410
RF33	RF33	25'	8.000"	162.710	272.300	75.410
RF34	RF34	24'	13.441"	162.710	272.300	75.410
RF35	RF35	23'	20.322"	162.710	272.300	75.410
RF36	RF36	22'	32.660"	162.710	272.300	75.410
RF37	RF37	21'	41.470"	162.710	272.300	75.410
RF38	RF38	20'	41.470"	162.710	272.300	75.410
RF39	RF39	19'	34.712"	162.710	272.300	75.410
RF40	RF40	18'	24.745"	162.710	272.300	75.410
RF41	RF41	17'	1.771"	162.710	272.300	75.410
RF42	RF42	16'	1.771"	162.710	272.300	75.410
RF43	RF43	15'	4.661"	162.710	272.300	75.410
RF44	RF44	14'	8.000"	162.710	272.300	75.410
RF45	RF45	13'	11.325"	162.710	272.300	75.410
RF46	RF46	12'	14.661"	162.710	272.300	75.410
RF47	RF47	11'	17.177"	162.710	272.300	75.410
RF48	RF48	10'	20.322"	162.710	272.300	75.410
RF49	RF49	9'	32.660"	162.710	272.300	75.410
RF50	RF50	8'	41.470"	162.710	272.300	75.410
RF51	RF51	7'	41.470"	162.710	272.300	75.410
RF52	RF52	6'	34.712"	162.710	272.300	75.410
RF53	RF53	5'	24.745"	162.710	272.300	75.410
RF54	RF54	4'	1.771"	162.710	272.300	75.410
RF55	RF55	3'	1.771"	162.710	272.300	75.410
RF56	RF56	2'	4.661"	162.710	272.300	75.410
RF57	RF57	1'	8.000"	162.710	272.300	75.410
RF58	RF58	0'	11.325"	162.710	272.300	75.410

COPY AVAILABLE TO DDC DOES NOT  
PERMIT FULLY LEGIBLE PRODUCTION

FIGURE 2-7c. TRANSMITTER-RECEIVER DISTANCES

Copy available to DDC does not  
permit fully legible reproduction

## FIGURE 2-7d. TRANSMITTER-RECEIVER DISTANCES

PAGE 2

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B026-47011/47013

TRANSMITTER	RECEIVER	A T C T LENGTH	THETA-AT	PHI-AT	THETA-N	PHI-N	ANGLE-A TC AT
NFC	NF1	57° 6-414°"	-3-973	181-948	-32-000	273-007	00-192
	NF2	56° 2-100°"	-4-041	181-982	-31-000	272-733	00-429
	NF3	55° 10-126°"	-4-108	181-993	-33-000	272-733	00-383
	NF4	54° 11-152°"	-4-126	182-005	-34-000	272-733	00-249
	NF5	54° 1-177°"	-4-240	182-014	-35-000	272-733	00-197
	NF6	53° 2-149°"	-4-313	181-981	-32-000	273-007	00-196
	NF7	52° 4-206°"	-4-382	181-967	-36-000	273-007	00-265
	NF8	51° 5-219°"	-4-460	181-932	-37-000	273-007	00-174
	NF9	50° 6-244°"	-4-526	181-937	-38-500	273-007	00-019
	NF10	50° 3-919°"	-7-016	180-620	-19-500	275-333	02-049
	NF11	54° 2-705°"	-6-032	181-018	-25-000	274-517	00-467
	NF12	54° 1-905°"	-5-220	181-441	-28-000	273-750	00-565
	NF13	54° 0-774°"	-3-269	182-619	-40-000	272-013	00-374
	LF1	8° 1-308°"	-20-313	189-385	-65-500	272-267	00-596
	LF2	5° 10-130°"	-28-534	193-134	-45-500	272-267	00-718
	LF3	2° 11-490°"	-46-069	204-224	-68-000	271-983	00-010
	LF4	4° 1-763°"	-39-645	239-949	-69-500	272-005	00-669
	LF5	6° 2-905°"	-26-139	248-162	-70-500	272-005	01-124
	LF6	6° 9-072°"	-18-305	352-946	-71-500	272-300	01-708
	LF7	11° 1-747°"	-14-340	354-572	-72-500	272-300	01-C16
	LF8	13° 9-530°"	-11-146	355-939	-72-500	272-005	01-592
	LF9	8° 6-692°"	-95-865	90-000	-212-267	01-615	
	LF10	6° 10-097°"	-18-513	90-000	-47-000	274-847	01-411
	LF11	5° 0-489°"	-64-592	90-000	-95-000	274-983	00-346
	LF12	3° 7-052°"	-80-811	90-000	-62-500	273-750	00-474
	LF13	3° 1-031°"	-37-802	270-000	-72-000	274-200	
	G1	14° 5-160°"	-35-058	31-573	-28-500	276-450	01-795
	G2	16° 10-1820°"	-33-944	20-146	-28-500	276-450	01-522
	G3	2C° 5-640°"	-27-487	24-683	-24-500	276-450	01-358
	G4	21° 0-433°"	-26-222	23-833	-28-500	276-450	01-143
	G5	13° 9-095°"	-33-605	0-313	-38-000	276-333	00-821
	G6	14° 3-814°"	-32-129	0-295	-38-000	276-333	00-571
	G7	19° 6-919°"	-22-857	23-842	-38-500	276-400	00-530
	G8	20° 1-700°"	-22-181	23-015	-38-500	276-400	00-176
	G9	19° 11-862°"	-33-747	34-684	-24-000	276-450	00-467
	G10	20° 5-401°"	-32-887	33-420	-23-500	276-450	00-428
	H1	11° 1-236°"	-16-123	105-042	-63-500	272-450	14-638
	H2	16° 7-342°"	-18-097	8-431	-64-000	275-933	14-669
	H3	17° 11-347°"	-12-368	3-304	-69-000	274-567	26-C14
	H4	17° 10-165°"	-6-929	321-026	-74-000	270-600	01-230
	H5	42° 10-457°"	-3-817	2-010	-76-500	273-350	00-575
	H6	5C° 10-217°"	-4-135	5-327	-69-000	270-717	00-786
	H7	59° 5-213°"	-4-191	5-526	-71-000	274-267	00-245
	H8	70° 4-413°"	-3-004	5-034	-73-000	274-333	00-933
	H9	59° 0-832°"	-2-517	1-173	-78-500	272-817	00-266
	H10	29° 1-162°"	-1-595	317-392	-80-000	270-417	00-915

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PERMIT FULLY LEGIBLE PRODUCTION

## X2C RETRACTABLE STRUT EXTENCE 4 FEET

TRANSMITTER	RECEIVER	R TO T LENGTH	T-R STRUT	F+I-RT	F+I-A	F+I-T-A	F+I-T	F+I-C
X2C								
HF1		570 9.830*	-4.376	1e2.321	-32.000	274.CCC	274.CCC	274.CCC
HF2		560 10.132*	-4.562	1e2.361	-33.009	272.713	272.713	272.713
HF3		550 11.174*	-5.043	1e2.378	-34.000	272.722	272.722	272.722
HF4		540 11.217*	-2.167	1e2.397	-34.000	272.733	272.733	272.733
HF5		540 2.256*	-5.216	1e2.412	-35.000	272.744	272.744	272.744
HF6		540 3.260*	-5.255	1e2.396	-35.000	273.CCC	273.CCC	273.CCC
HF7		540 5.312*	-5.460	1e2.378	-36.000	273.001	273.001	273.001
HF8		510 6.339*	-5.475	1e2.351	-37.000	273.CCC	273.CCC	273.CCC
HF9		500 9.378*	-5.516	1e2.362	-38.000	273.CCC	273.CCC	273.CCC
HF10		540 5.417*	-7.572	1e1.018	-19.000	275.221	275.221	275.221
HF11		540 6.946*	-6.946	1e1.417	-25.000	274.517	274.517	274.517
HF12		540 1.126*	-6.123	1e1.859	-28.000	273.750	273.750	273.750
HF13		540 1.721*	-4.237	1e2.096	-40.000	272.C13	272.C13	272.C13
LF1		640 6.417*	-25.517	1e2.145	-65.000	272.267	272.267	272.267
LF2		640 6.956*	-35.327	1e2.136	-65.000	272.267	272.267	272.267
LF3		400 9.095*	-52.213	210.964	-68.CCC	271.973	271.973	271.973
LF4		400 10.602*	-46.844	323.914	-69.500	272.CCC	272.CCC	272.CCC
LF5		600 9.203*	-32.810	345.251	-70.500	272.CCC	272.CCC	272.CCC
LF6		600 1.625*	-23.664	350.397	-71.500	272.300	272.300	272.300
LF7		1100 5.369*	-16.737	352.602	-72.500	272.300	272.300	272.300
LF8		1400 6.372*	-14.767	354.359	-72.500	272.300	272.300	272.300
LF9		1400 1.719*	-61.640	90.CCC	-39.500	272.267	272.267	272.267
LF10		700 5.621*	-64.650	90.CCC	-47.CCC	274.967	274.967	274.967
LF11		700 9.452*	-71.859	90.CCC	-55.000	274.583	274.583	274.583
LF12		400 5.553*	-17.456	90.000	-62.500	273.CCC	273.CCC	273.CCC
LF13		400 5.656*	-44.181	770.CCC	-72.500	273.767	273.767	273.767
G1		1600 9.852*	-17.392	1.C.192	-28.500	272.005	272.005	272.005
G2		1700 2.364*	-36.404	33.000	-28.500	274.967	274.967	274.967
G3		2000 5.210*	-29.526	23.595	-28.500	276.450	276.450	276.450
G4		2100 5.710*	-29.104	22.778	-28.500	276.450	276.450	276.450
G5		1400 3.467*	-26.659	258.438	-38.000	276.333	276.333	276.333
G6		1400 9.646*	-35.122	350.524	-38.000	276.333	276.333	276.333
G7		1900 5.748*	-25.467	22.743	-38.000	276.450	276.450	276.450
G8		2000 4.500*	-24.721	21.645	-38.000	276.450	276.450	276.450
G9		2000 4.101*	-36.222	30.069	-38.000	276.450	276.450	276.450
G10		2000 4.246*	-45.314	32.363	-38.000	276.450	276.450	276.450
H1		1100 2.143*	-20.447	197.042	-63.000	272.853	272.853	272.853
H2		1400 10.427*	-2.C.798	7.226	-64.000	275.923	275.923	275.923
H3		1400 1.765*	-15.208	2.075	-64.000	274.567	274.567	274.567
H4		1400 0.507*	-19.466	249.847	-76.000	276.600	276.600	276.600
H5		400 11.169*	-75.335	1.507	-76.000	273.350	273.350	273.350
H6		400 10.705*	-16.177	6.C.64	-66.000	270.713	270.713	270.713
H7		400 2.684*	-5.374	5.165	-71.000	274.767	274.767	274.767
H8		400 4.678*	-3.710	4.150	-71.000	274.333	274.333	274.333
H9		1400 1.323*	-13.614	3.C.65	-71.000	273.917	273.917	273.917
H10		1400 1.443*	-13.777	4.C.66	-71.000	270.417	270.417	270.417

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FIGURE 2-7e. TRANSMITTER-RECEIVER DISTANCES

## x2E RETRACTABLE STRUT EXTENDED 5 FEET

TRANSMITTER	RECEIVER	WIC T LENGTH	WIC T PT	WIC T-PT	PT-1-A	PT-1-B	PT-1-C	ACCLF-A 1C PT	8/19/64
x2L									
HFI	511 11.0.C75**	-5.821	142.652	-32.000	271.CC7	87.219			
HF2	521 11.4.CC0**	-5.921	142.692	-33.CCC	272.732	86.EC2			
HF3	561 0.4.C60**	-6.018	142.721	-33.CCC	272.732	86.727			
HF4	221 1.522**	-6.018	142.742	-34.CCC	272.732	86.574			
HF5	541 2.875**	-6.211	142.765	-35.000	272.732	86.416			
HF6	231 4.622**	-6.211	142.746	-35.CCC	273.007	86.294			
HF7	521 6.621**	-6.418	142.744	-36.CCC	274.007	86.445			
HF8	511 7.716**	-6.532	142.723	-37.000	273.CC7	86.3CC			
HF9	521 10.776**	-6.628	142.742	-38.500	271.CC7	86.CEF			
HF10	241 7.194**	-9.967	141.572	-39.500	275.332	86.1C4			
HF11	541 9.657**	-7.731	141.771	-40.CCC	274.517	85.CS8			
HF12	541 4.608**	-7.185	142.213	-48.000	273.75C	87.582			
HF13	541 2.9C0**	-7.5245	143.445	-49.000	272.012	85.623			
UF1	91 5.741**	-31.227	164.355	-65.500	272.267	56.821			
UF2	71 1.101**	-41.150	206.556	-65.500	272.267	45.631			
UF2	71 7.762**	-56.659	216.254	-69.000	271.982	27.4C5			
UF4	61 8.605**	-52.276	329.CC7	-69.500	272.005	30.971			
UF5	71 4.843**	-38.660	142.C55	-70.500	272.005	47.328			
UF6	81 7.377**	-28.753	348.162	-71.500	272.3CC	56.251			
UF7	111 10.302**	-29.061	450.662	-72.500	272.30C	64.621			
UF8	141 4.C85**	-18.463	352.562	-72.500	272.005	69.7C4			
UF9	81 1C.143**	-65.441	50.CCC	-75.500	272.267	75.044			
UF10	111 2.691**	-69.614	90.CCC	-47.000	274.867	63.231			
UF11	61 7.875**	-77.188	90.070	-55.000	274.901	47.715			
UF12	51 6.C20**	-87.587	276.CCC	-62.500	273.75C	26.C11			
UF13	51 4.764**	-48.981	270.660	-72.500	270.767	23.C12			
61	3.630**	-40.879	28.931	-28.500	276.45C	86.E52			
G2	171 1.AG12**	-29.25C	27.55C	-28.500	276.45C	66.563			
G3	211 1.918**	-12.452	22.027	-48.500	276.45C	87.215			
G4	211 2.501**	-21.450	21.825	-48.500	276.45C	87.1C8			
G5	141 1C.7C0**	-38.586	256.774	-38.000	276.333	6C.451			
G6	151 4.527**	-38.005	356.951	-36.000	276.333	61.292			
G7	201 1.629**	-28.054	21.751	-38.500	276.40C	P3.669			
G8	201 5.226**	-27.274	26.982	-38.500	274.567	71.E68			
G9	201 9.257**	-38.653	32.629	-24.000	276.40C	53.4FC			
G10	211 2.690**	-37.700	31.4C3	-23.500	276.45C	93.570			
G11	1C.0.C79**	-24.758	1EH.HC5	-63.500	272.85C	65.366			
G12	151 2.232**	-23.508	6.149	-64.000	274.593	65.CE4			
G13	181 4.958**	-18.594	6.59E	-69.000	274.567	71.E68			
G14	121 2.053**	-12.722	48.782	-78.000	270.6CC	75.1C2			
G15	41 6.217**	-6.312	1.CC1	-76.500	273.35C	83.329			
G16	1C.1.421**	-6.243	4.579	-69.000	270.717	85.536			
G17	1C.446**	-11.564	4.324	-71.000	274.767	84.357			
G18	1C.197**	-4.645	4.443	-73.000	274.333	85.7C5			
G19	1C.0.911**	-4.451	4.48E	-78.500	272.617	85.251			
G20	51 7.193**	-31.CC1	56.706	-8C.000	270.447	85.612			

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FIGURE 2-7f. TRANSMITTER-RECEIVER DISTANCES

## X4 FIXED SIGHT AT FRAME 82

PCT

PCT

TRANSMITTER	RECEIVER	R TC 1 LENGTH	T+FTA-1	PHI-1	TH-FTA-1	PHI-1-A	ANGLE-1 TC RT
X4							
HF1	116°	9.450°	-3.452	1EC.866	-32.000	273.007	85.965
HF2	115°	9.723°	-3.481	1EC.867	-33.000	272.733	85.667
HF3	114°	10.741°	-3.505	180.864	-33.000	272.733	85.655
HF4	113°	11.759°	-3.537	180.866	-34.000	272.733	85.673
HF5	113°	11.775°	-3.562	1EC.867	-35.000	272.733	85.692
HF6	112°	2.787°	-3.592	1EC.867	-35.000	273.007	89.715
HF7	111°	4.801°	-3.615	180.816	-36.000	273.007	85.643
HF8	110°	5.813°	-3.649	180.756	-37.000	273.007	89.712
HF9	109°	8.829°	-3.674	1EC.785	-38.500	273.007	89.450
HF10	113°	3.964°	-4.893	180.190	-19.500	275.333	93.154
HF11	113°	3.073°	-4.420	180.361	-25.000	274.517	91.869
HF12	113°	2.433°	-4.331	180.552	-28.000	273.750	91.869
HF13	113°	1.274°	-3.095	181.184	-40.000	272.013	86.643
LF1	66°	9.182°	-5.030	180.888	-65.500	272.267	85.955
LF2	64°	3.259°	-5.198	180.858	-65.500	272.267	85.869
LF3	61°	9.441°	-5.456	180.854	-68.000	271.983	85.365
LF4	96°	3.526°	-5.786	1EC.906	-69.500	272.005	84.564
LF5	63°	9.821°	-6.167	180.925	-70.500	272.005	84.548
LF6	51°	1.016°	-6.458	180.917	-71.500	272.300	84.477
LF7	48°	7.238°	-6.844	1EC.965	-72.500	272.300	83.875
LF8	45°	10.346°	-7.137	18C.944	-72.500	271.983	83.514
LF9	60°	C.860°	-9.694	175.146	-39.500	272.267	85.266
LF10	59°	9.383°	-9.527	176.133	-47.000	274.867	85.521
LF11	55°	6.446°	-7.348	177.685	-55.000	274.983	86.136
LF12	59°	4.442°	-6.356	179.241	-62.500	273.750	86.438
LF13	55°	3.473°	-5.670	182.567	-72.000	272.300	84.675
G1	45°	8.177°	-14.535	171.329	-28.500	276.450	85.663
G2	49°	C.526°	-14.728	171.258	-28.500	276.450	85.862
G3	44°	11.692°	-16.109	169.611	-28.500	276.450	86.441
G4	44°	6.138°	-16.344	169.445	-28.500	276.450	86.447
G5	48°	8.657°	-12.622	179.674	-28.000	276.333	87.401
G6	48°	C.433°	-12.795	179.669	-38.000	276.333	87.256
G7	44°	5.374°	-13.544	169.592	-38.500	276.450	85.867
G8	42°	S.731°	-14.045	169.636	-39.000	276.450	85.264
G9	48°	5.519°	-16.959	167.963	-24.000	276.450	89.116
G10	47°	1C.042°	-17.187	167.780	-23.500	276.450	90.352
H1	65°	10.761°	-5.015	180.660	-61.500	272.850	86.438
H2	42°	6.213°	-11.562	176.137	-64.000	275.933	82.463
H3	42°	C.994°	-9.402	176.316	-69.000	274.567	83.492
H4	41°	1C.8C9°	-7.112	183.519	-76.000	270.650	72.513
H5	17°	4.406°	-19.805	173.995	-76.500	273.350	72.513
H6	11°	10.636°	-34.256	146.954	-69.000	270.717	61.598
H7	5°	2.460°	-51.261	9C.CCC	-71.000	274.767	57.651
H8	14°	4.559°	-27.545	3C.094	-73.000	274.322	70.440
H9	5°	S.605°	-75.564	9C.000	-78.000	272.817	25.628
H10	5°	7.664°	-84.000	27C.000	-80.000	270.417	15.959

FIGURE 2-7g.

TRANSMITTER-RECEIVER DISTANCES

2-15g

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PERMIT FULLY LEGIBLE PRODUCTION

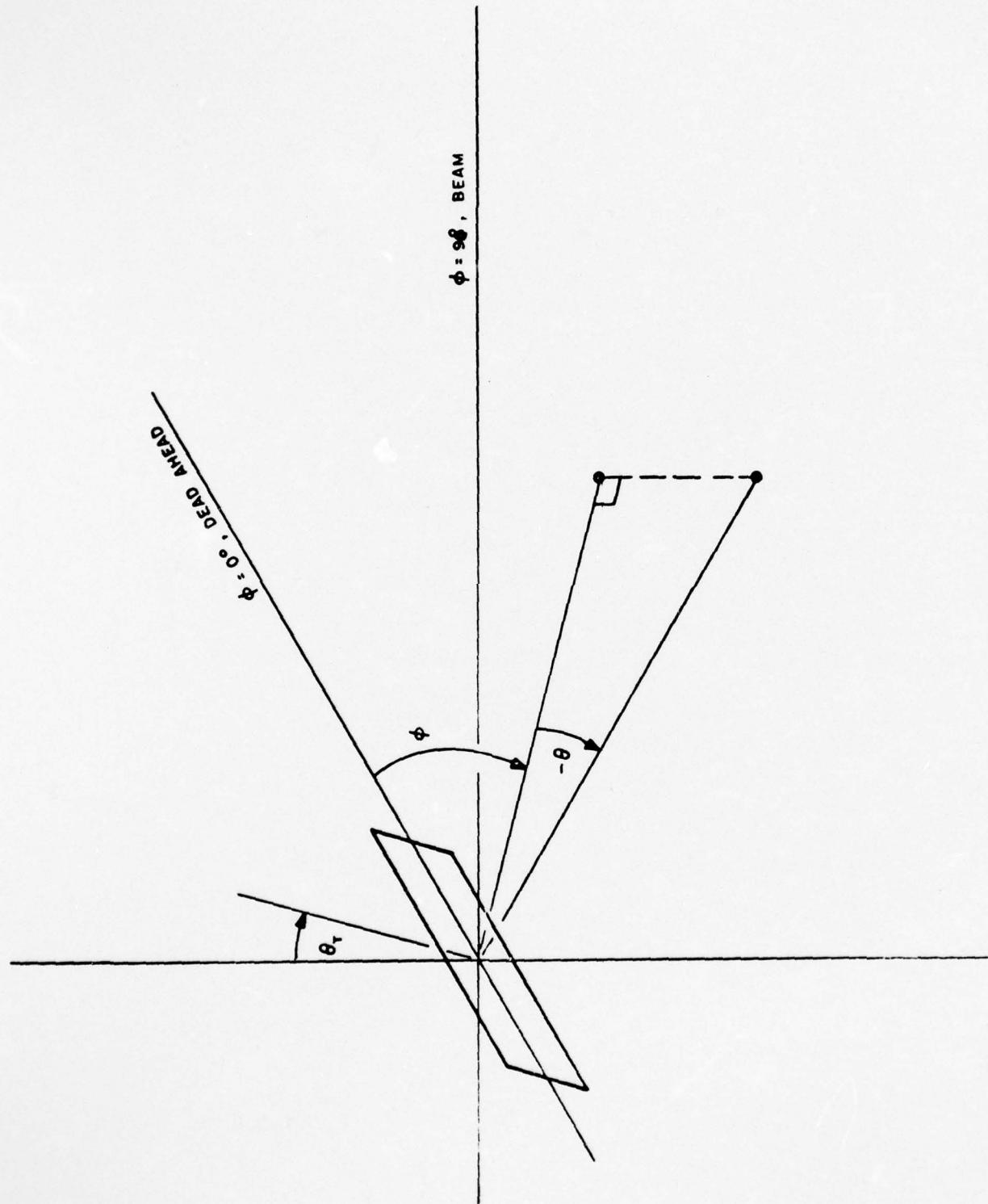


FIGURE 2-8. C/P SONAR COORDINATE SYSTEM

SECTION III  
SHIPBOARD INSTRUMENTATION

A. RECORDING CENTER

A functional block diagram of the PURVIS II instrumentation appears in Figure 3-1. The equipment configuration within each rack of the Shipboard Recording Center is described in Figure 3-2. This facility contains all of the instruments necessary for amplifying signal conditioning and recording on magnetic tape, up to 60 data channels plus 10 timing and tape speed control signals simultaneously. In addition, the equipment contains variable and fixed filters, power amplifiers, a direct write recording oscilloscope, waveform analyzers, and other instruments useful in performing a "quick-look" analysis of data prior to, during, or after a "run" has been completed. All equipment needed to calibrate the tape recorders is also included within the facility.

A detailed description of the equipment within the Shipboard Recording Center used during the PURVIS I Sea Trials appears in Reference 1. This configuration was basically retained for the PURVIS II Sea Trials with the following modifications:

- a) The number of Signal Conditioning Amplifiers (SCAs) was increased from 48 to 84. This provided the capability of connecting each sonar transducer (hydrophone or accelerometer) preamplifier output directly to a SCA. In this manner the "patching" of signals (limited by the number of tape recording channels to a maximum of 48 high bandwidth channels simultaneously) was performed at the SCA outputs, where the amplified signal levels were considerably higher than at the SCA inputs. (The latter technique was used for PURVIS I.)

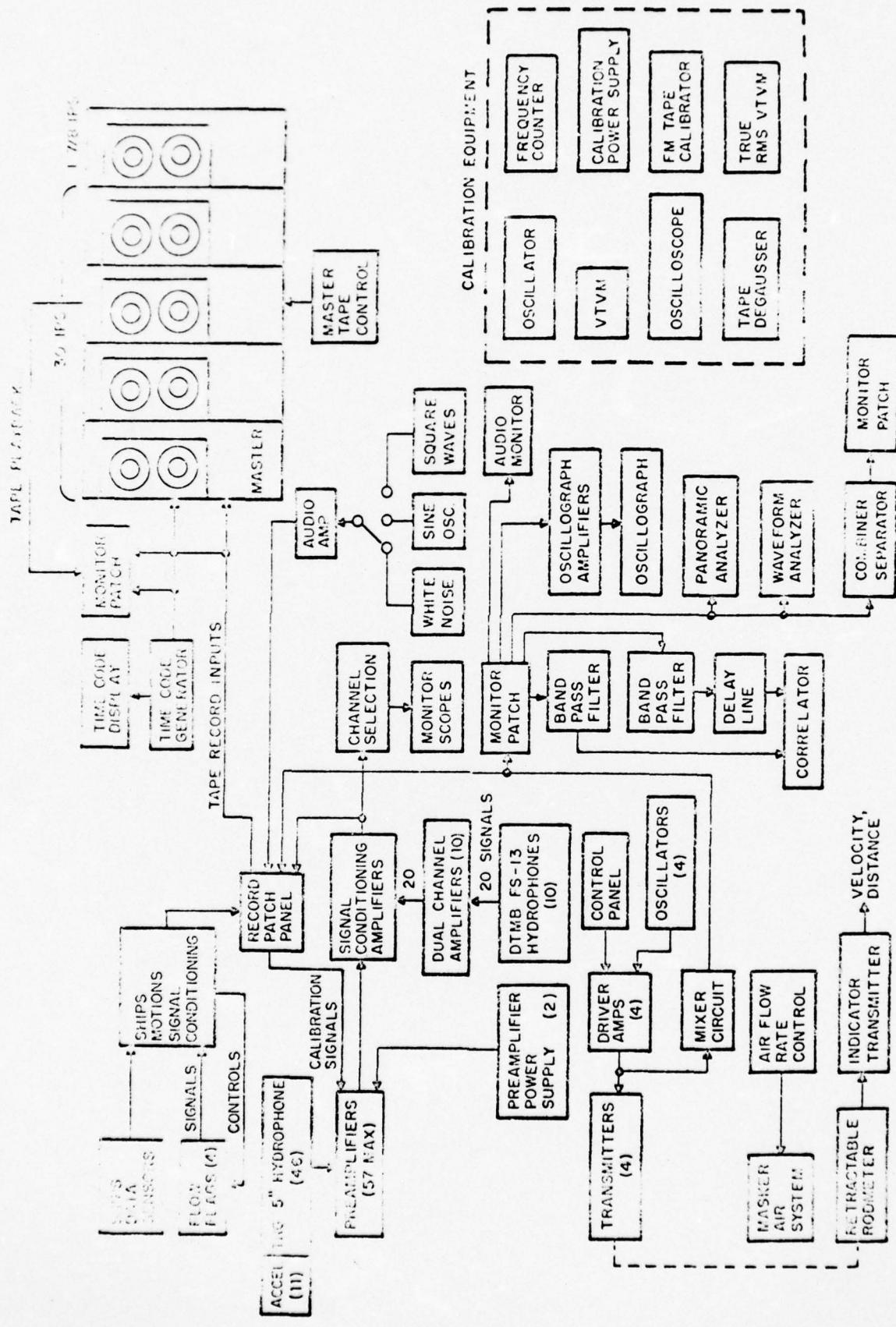
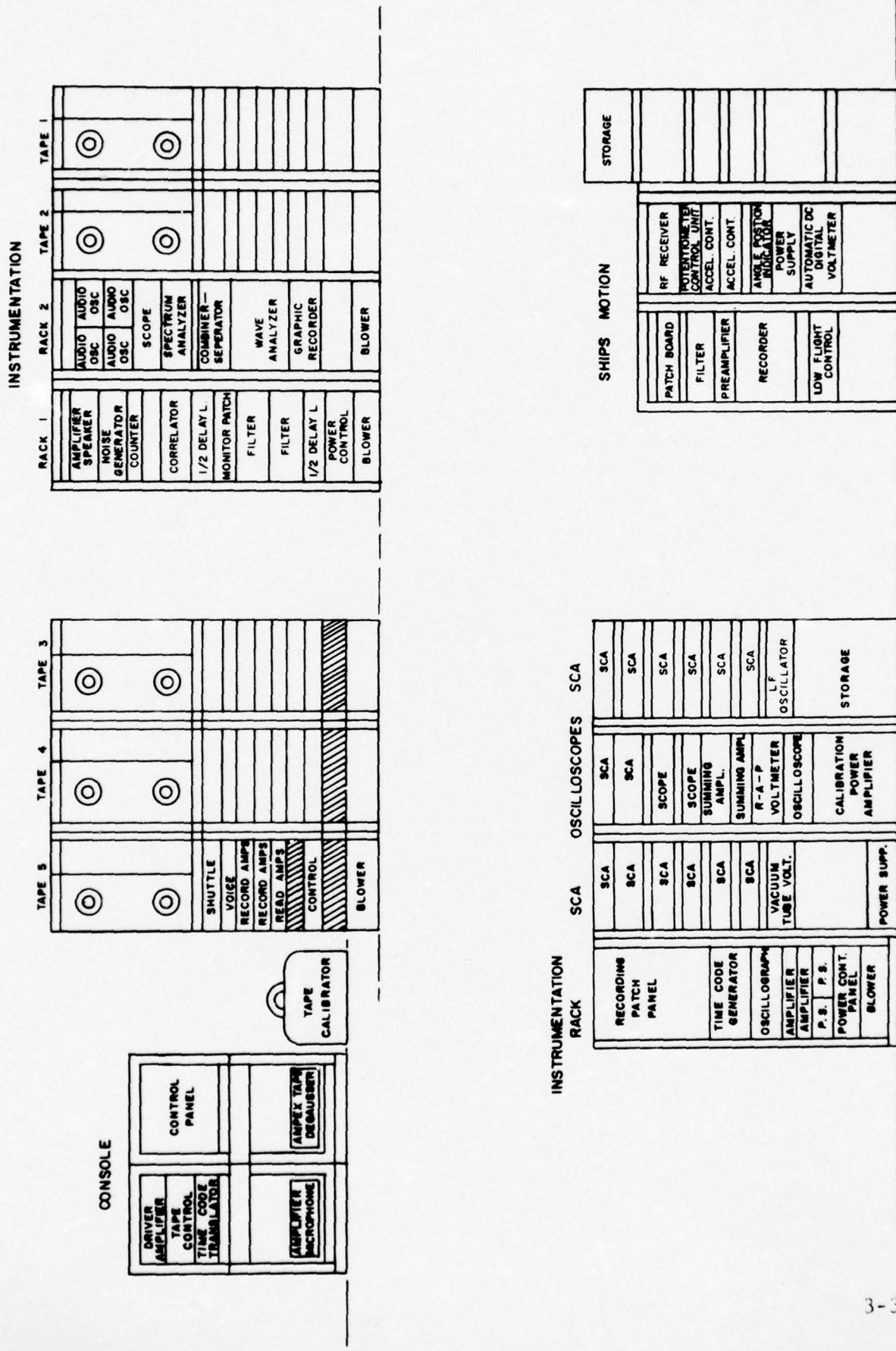


FIGURE 3-1. PURVIS II INSTRUMENTATION, BLOCK DIAGRAM

B026-47011/47013

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FIGURE 3-1 PURVIS II SHIPBOARD RECORDING CENTER



- b) Ten variable gain dual-channel and summing amplifiers were added to the Recording Center for the acoustic and vibration signals originating at the 10 FS-13 hydrophones located in Sea Chest 1. The gain of each channel was set at 20 db and essentially served as a preamplifier for the signals from Sea Chest 1.
- c) The pushbutton oscillator used for PURVIS I was supplemented by the addition of 3 more units, in order to have 4 variable frequency sources for the four driver-amplifiers and acoustic transmitters.
- d) A "combiner-separator" panel was fabricated and installed. This unit used a summing network for combining a monitor output signal for each driver-amplifier into one composite signal which could then be recorded on the magnetic tapes during transmission tests. In addition, it contained fixed-frequency, narrow band-pass filters which could be used to separate any one frequency of the four transmitting frequencies from a hydrophone output during either the "real time" or during tape playback.
- e) A flow flag instrumentation and control panel was installed in the ship's motion electronics rack for conditioning the 400 Hz signals from the four flow flags, in DC signals suitable for magnetic tape recording at 1-7/8 ips.

Other modifications included a change in the cabling used (from the bulkhead terminal strips to the SCAs) from TTRS-16 to Triaxial type, adding new preamplifier power supplies and eliminating the calibration patch panel.

#### B. OTHER SHIPBOARD INSTRUMENTATION

The experiments planned for PURVIS II included transmission tests for determining the effects of bubble sweepdown,

ship's motion, etc., on the amplitude and phase of the received signals, at various hydrophones. For this purpose, three struts (2 fixed, 1 retractable) were installed on the port side of the ship, each containing a hydrophone suitable for transmitting. (A fourth transmitter had been installed in the Sonar Dome prior to the PURVIS I tests.) Four driver amplifiers were installed, one in the vicinity of each transmitter, to provide the necessary power amplification for the sinusoidal transmitting signals which were generated by test oscillators located in the Recording Center.

The output signals from most of the 46 5-inch hydrophones and 11 miniature accelerometers mounted on the rear mass of some of the hydrophones were connected to 20 db gain pre-amplifiers which were mounted on the back cover of each hydrophone sea chest. Since the hydrophones mounted in Sea Chest II were installed in a water-floodable area, the preamplifiers, which were not designed to be completely watertight, were mounted approximately 10 feet away in a dry area.

Four flow flags, each containing a rotating inductor, were fabricated by GD/EB and installed on the ship (3 on the port side, and 1 on the starboard side). These devices, operating with 400 Hz excitation, generated signals as a function of the position changes of the flag due to water flow around it.

The masker system (bubble generators) was modified to permit three different flow rates of bubbles from each masker.

A velocity transmitter-indicator unit was installed near the retractable strut, since this device was basically a velocity sensing rodmeter which was modified by the addition of a transmitting hydrophone.

SECTION IV  
SUMMARY OF RUNS

A. RUN CLASSIFICATION/DESCRIPTION

The PURVIS II Sea Trials were performed in two basic series of tests: a) Naval Architecture (Photographic) and b) Acoustics. Each run in both series was assigned a pre-determined three-digit run number. The magnetic tape data recorded during the run was identified by both voice annotation and the range time code, which contained the thumb-wheel controlled run number within the code recorded on each tape. The external photographic data was identified by photographing an underwater slate containing the appropriate run number prior to the start of each. A brief description of the test conditions for each series appears below.

B. NAVAL ARCHITECTURE SERIES

The Naval Architecture Series is more commonly described as the photographic series, since both external and on-board (Fish-eye) cameras were employed to obtain photographic data of the bubble flow patterns associated with both natural bubbles and artificial bubbles injected by the shipboard Masker System and /or Bow Wave Hose. The run numbers for the photographic series were generally subdivided into 3 "hundreds" series as follows:

- "0" hundred (i.e., 021) No Maskers were used
- "1" hundred (i.e., 114) Masker No. 3 used
- "2" hundred (i.e., 216) Masker Nos. 2 & 4 used

A tabulation of all photographic runs appears in Appendix A.

C. ACOUSTIC SERIES

The Acoustic Series was identified by run numbers between 300 and 999. The general description of each "hundred"

series was as follows:

- |                         |   |      |
|-------------------------|---|------|
| "3" hundred (i.e., 336) | Passive Runs, ships heading WRT sea   | 0°   |
| "4" hundred (i.e., 448) | " " "   | 90°  |
| "5" hundred (i.e., 550) | " " "   | 180° |
| "6" hundred (i.e., 642) | " " "   | 270° |
| "7" hundred (i.e., 782) | Transmission runs, various headings   |      |
| "8" hundred (i.e., 835) | Transmission runs and electrical calibrations   |      |
| "9" hundred (i.e., 970) | Special tests, such as Ship's motion data only, electrical calibrations, overside acoustic calibrations, etc. |      |

A complete tabulation of all Acoustic Series runs in numerical order appears in Appendix B-2. A cross-referenced tabulation of these runs by calendar date appears in Appendix B-1.

## SECTION V

IN-SITU CALIBRATION

## A. GENERAL DESCRIPTION

In-situ calibrations were performed at the TOTO test area during July 6-12, 1966. The hydrophone locations are shown in Figures 2-1a and 2-1b. A block diagram of the transmission instrumentation set-up is shown in Figure 5-1. The scanning frequency was derived from a General Radio Wave Analyzer. The current to the transmitter was monitored on both an oscilloscope and an RMS voltmeter. The transmitter current was kept constant by manually controlling the Wave Analyzer voltage while viewing the meter. The current (voltage across a 1 ohm resistor) was also recorded on a magnetic tape channel during each calibration along with the hydrophones covered at each station. The hydrophones and record combinations are summarized in Figure 5-2.

The in-situ calibrations were performed at five stations along the portside of the ship corresponding to the approximate center of each grouping of hydrophones. (See Figures 5-4 to 5-8)\*. The transmitting projector was placed at four different depths at each station while the transmitting frequency was swept from 50 Hz to 20 KHz.

The frequency was swept in three ranges: (1) 50 Hz to 3 KHz, (2) 2 KHz to 6 KHz, and (3) 5 KHz to 20 KHz, with a 1 KHz overlap between Parts 1 and 2 and between Parts 2 and 3. The sweep rates and currents are summarized in Figure 5-9. In addition, at each range, a 30 second "constant frequency" and a 30 second "ambient level" (no transmission) were recorded. The summary of runs is given in Figure 5-3. The distance between each 5" receiver and the J-9 transmitter (R to T length) for each calibration position is tabulated in Figure 5-10 (Note: R to T lengths for receivers D1H through D10H were not available for inclusion in this report).

\* Reference GD/EB Dwg. No. 200771

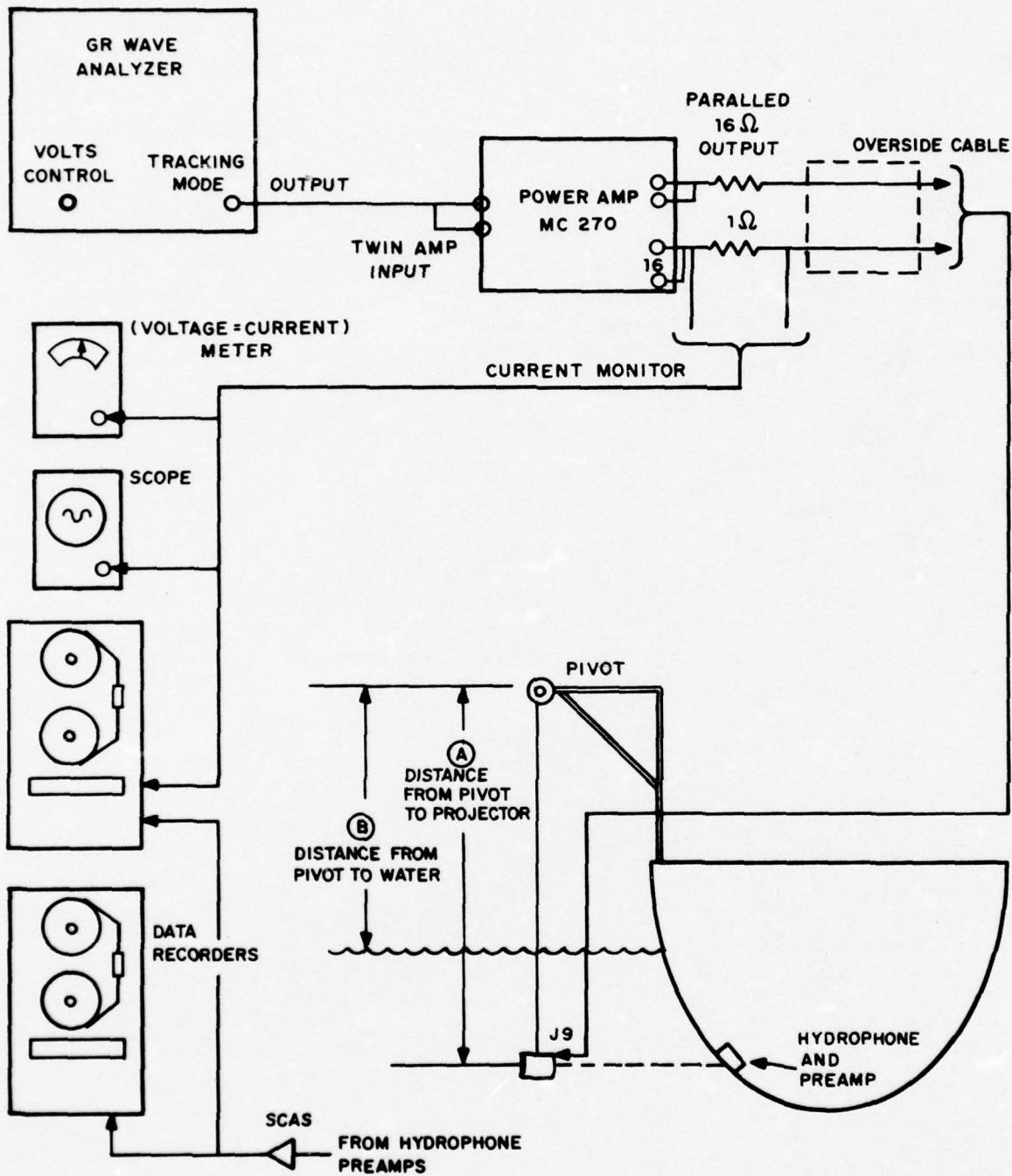


FIGURE 5-1. OVERTSIDE CALIBRATION TRANSMITTER SETUP

B. INSTRUMENTATION CONFIGURATION

Each of the five calibration stations were selected to provide an approximate central forward-aft position for each of the five groups of receiving elements, as follows:

Fr. 17-1/2: Station 1 - High Frequency Array (HF-1 through HF-13)

Fr. 22-1/2: Station 2 - Sea Chest 1 (D1H through D10H)

Fr. 48-1/2: Station 3 - Low Frequency Array (LF-1 through LF-13)  
and Hull Element H-1

Fr. 56-1/2: Station 4 - Sea Chest 2 (G-1 through G-10) and Hull  
Elements H-2 through H-4

Fr. 80-1/2: Station 5 - Hull Elements H-5 through H-10

The tape recording combinations were arranged so that only 2 of the 4 high speed 30 ips recorders were in use when the projector was at Stations 1, 2, 3, and 4, and only 1 was required for Station 5 calibrations, thus permitting an efficient utilization of the magnetic tapes for this operation.

The gain and frequency controls on each of the Signal Conditioning Amplifiers (SCAs) were set prior to the start of each of the three frequency sweeps. This was done by driving the transmitter at a constant pre-determined frequency within each band which yielded the maximum output from the transmitter. Hence, during Part 1(50 Hz to 3 KHz) the SCA gain controls were set with the transmitter input at 2.5 KHz, during Part 2 (2 KHz to 6 KHz) the setting frequency was 6 KHz, and during Part 3 (5KHz to 20 KHz) the setting frequency was 12.5 KHz. The SCA pre-emphasis (pre-whitening) controls were generally set in the "Flat" position for Parts 1 and 2, and in the 1 KHz position for Part 3.

FIGURE 5-2 RECORD COMBINATIONS USED AT EACH CALIBRATION STATION

STATION I:

Combination 1-1: Recorders 1,2,4\*

Hydrophones HF1 → HF13 (plus  
A1,4,5,7,9; LF1,9,13; G8; H5)

---

STATION II:

Combination 1-1: Recorders 3,4

Hydrophones D1H → D10H, D1A → D10A  
(plus H1, H10; LF8)

---

STATION III:

Combination 2-1: Recorders 1,2,4\*

Hydrophones LF1 → LF13 (plus  
H1; HF2,3,9,10,13; A5,7; D5H, D6H)

---

STATION IV:

Combination 2-1: Recorders 3,4

Hydrophones G1 → G10, H2, H3, H4  
plus A1,2,3,4,9,11; D1H, D2H, D4H,  
H5)

---

STATION V:

Combination 3-1: Recorders 2,4\*

Hydrophones H5 through H10 (plus  
A8,9; G5,8)

---

\* SERVO ONLY (used no tape)

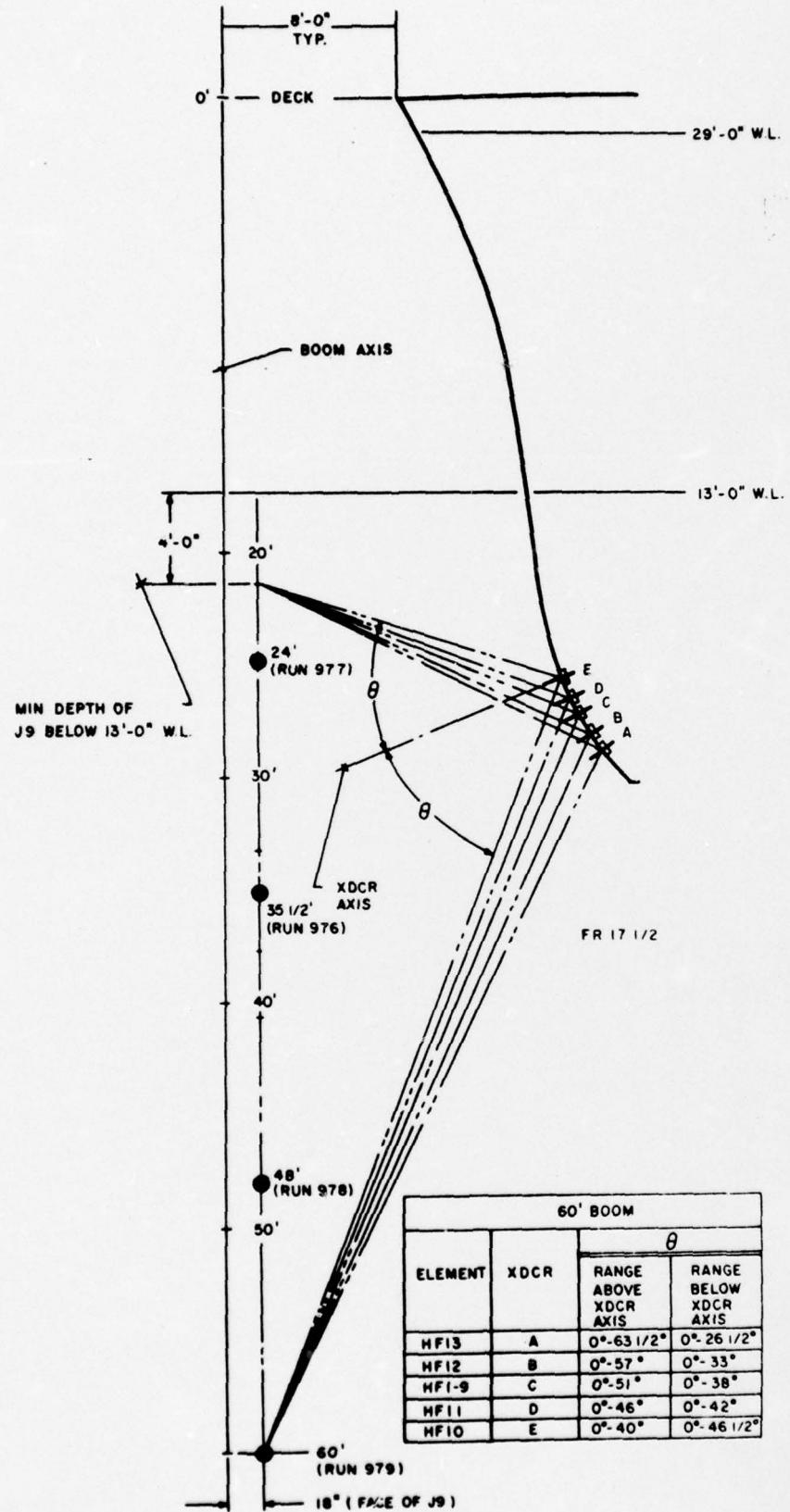
B026-47011/47013

A

(A)  
(B) } SEE FIG. 5-1

FIGURE 5-3. OVERSIDE CALIBRATION RUN SUMMARY

B026-47011/47013



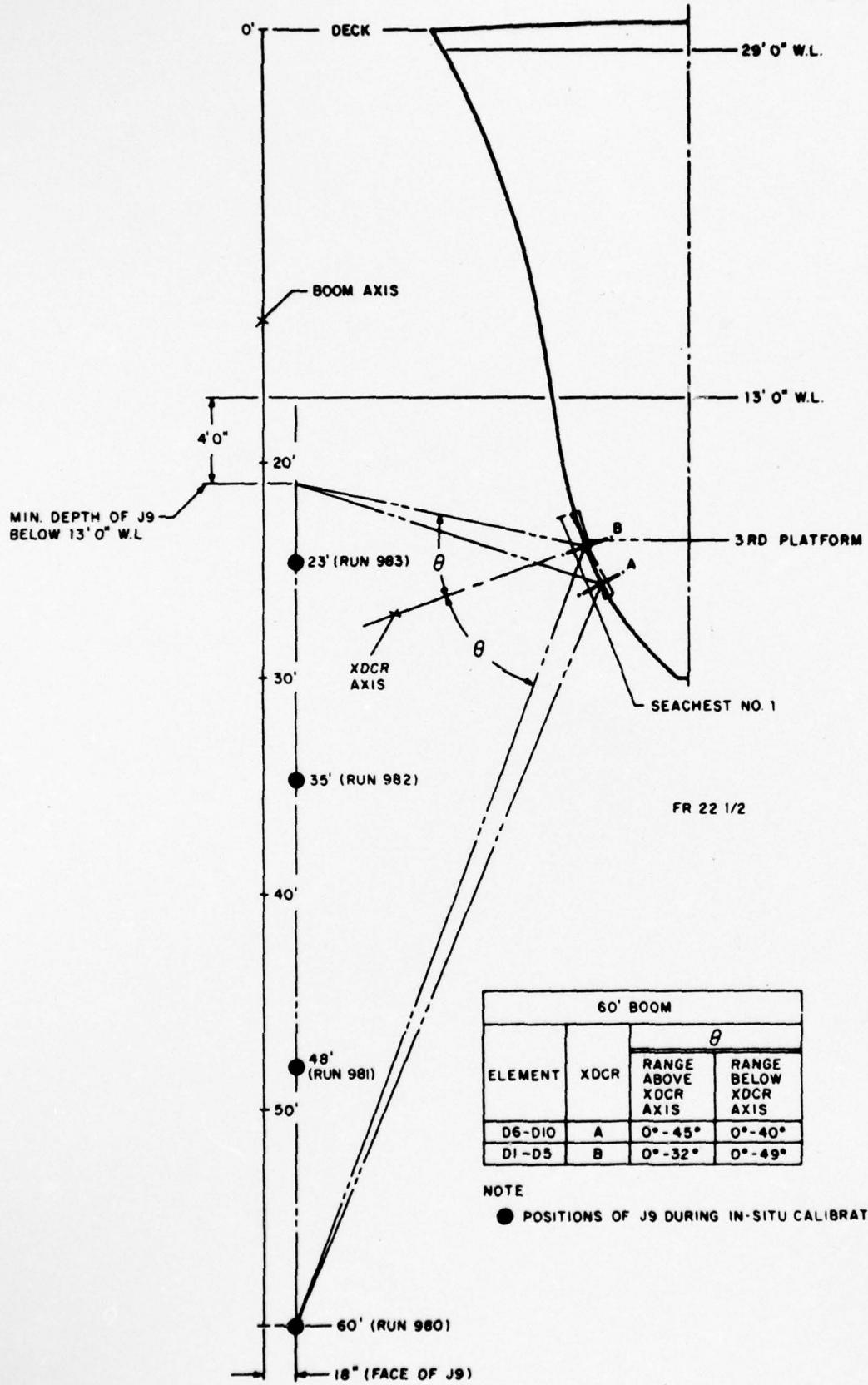
5-6

NOTE

● POSITIONS OF J9 DURING IN-SITU CALIBRATION

FIGURE 5-4 CALIBRATION STATION 1: HIGH-FREQUENCY ARRAY

B026-47011/47013



5-7

FIGURE 5-5 CALIBRATION STATION 2: SEA CHEST No. 1

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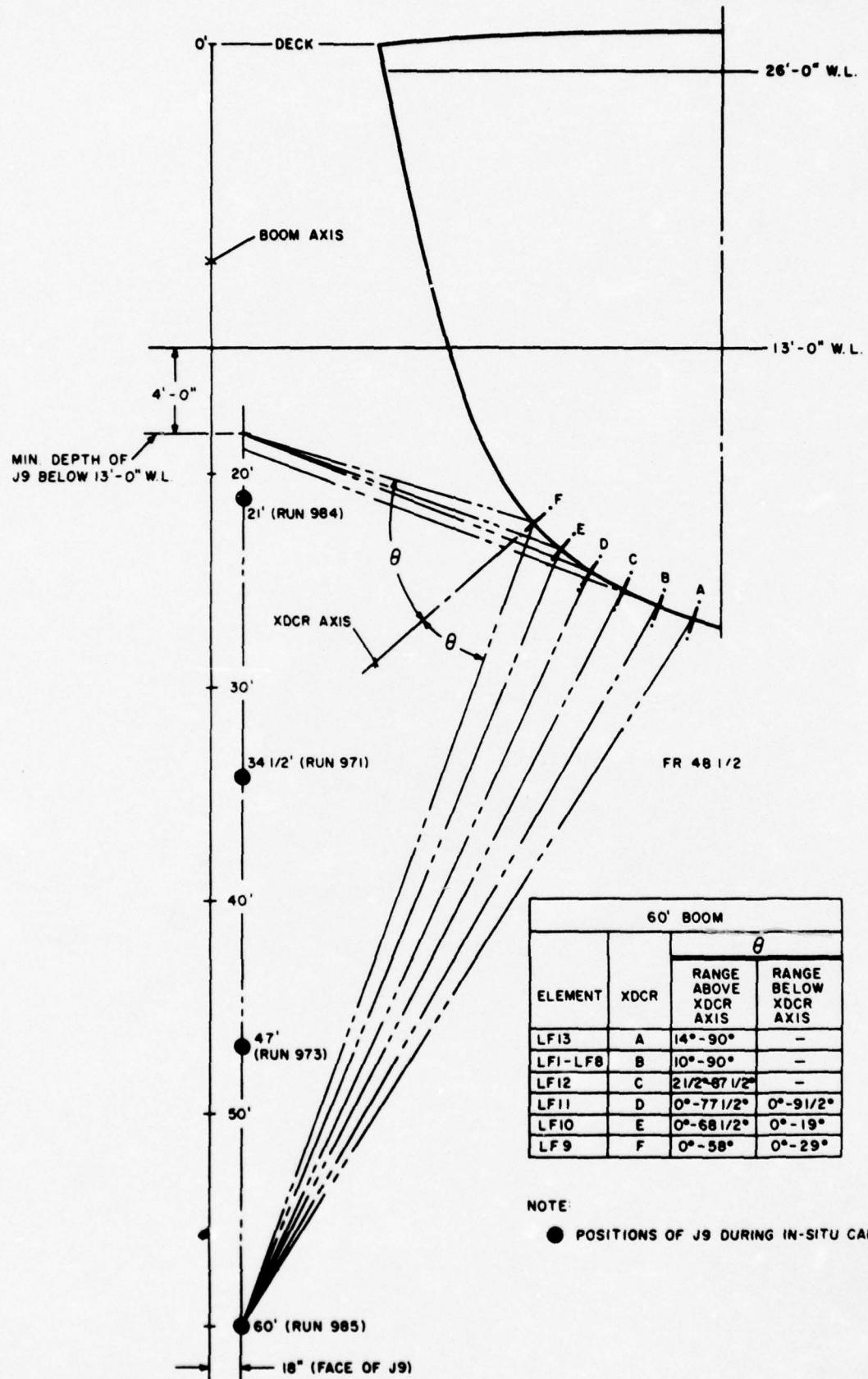
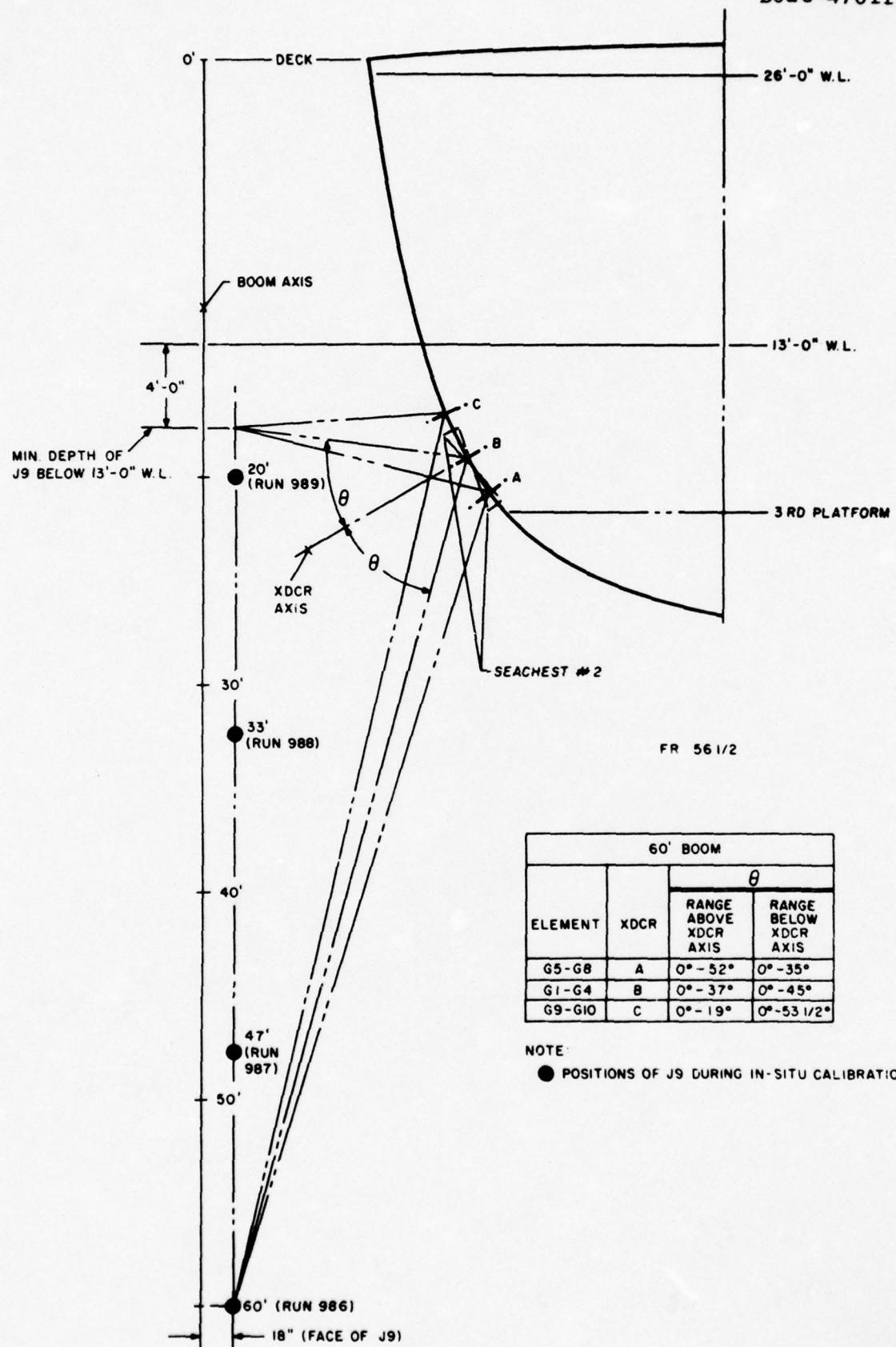


FIGURE 5-6 CALIBRATION STATION 3: LOW-FREQUENCY ARRAY

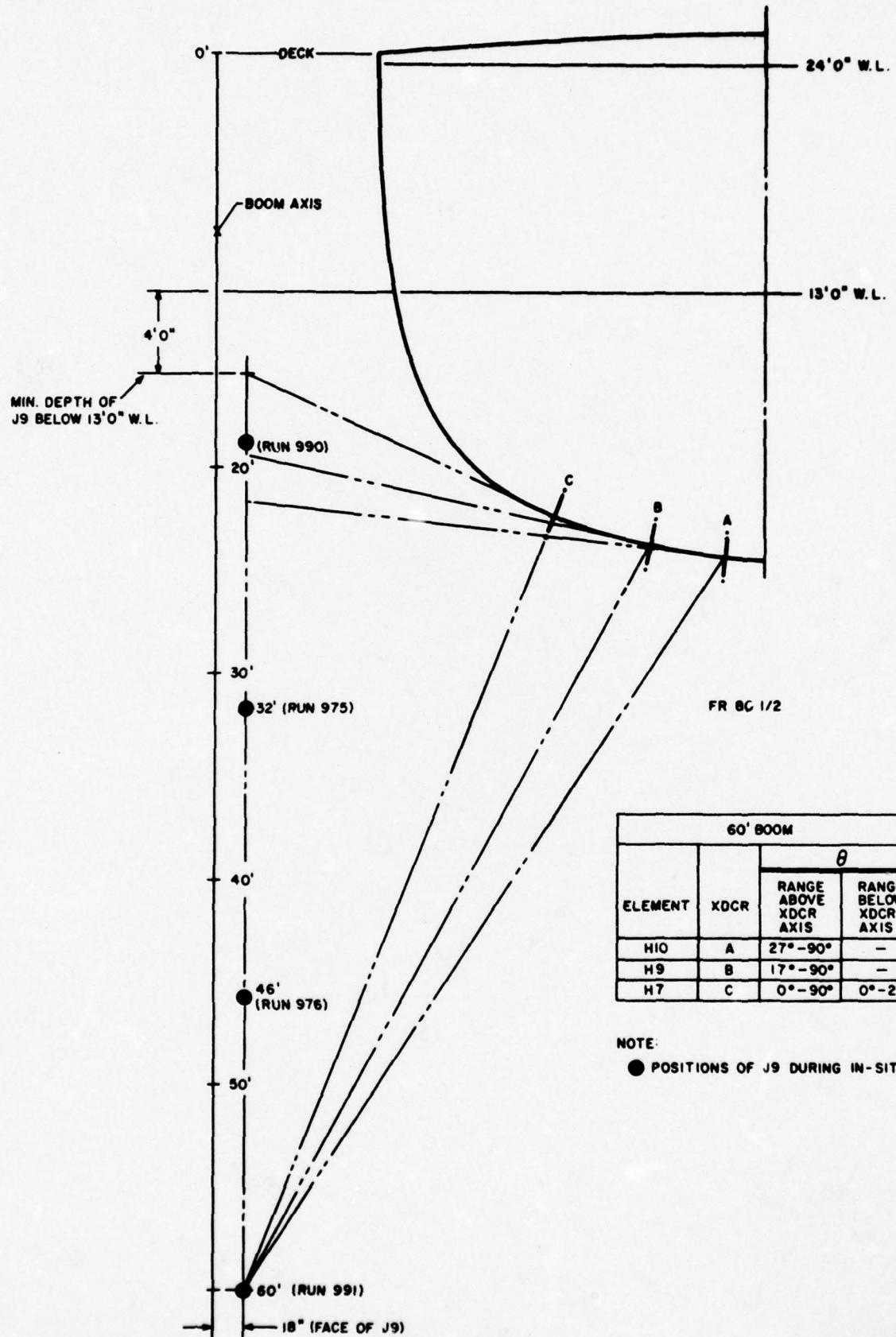
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5-9

FIGURE 5-7. CALIBRATION STATION 4: SEA CHEST No. 2

B026-47011/47013



5-10

FIGURE 5-8 CALIBRATION STATION 5: HULL ELEMENTS

Part 1

- a) Frequency: 50 hz to 30 khz sweep  
J9 current: 0.7 amperes (0.8 amperes initially)  
Sweep rate:  $\frac{(1.5 \times 1 \text{ ipm})}{2 \text{ in/KHz}} = 750 \text{ hz/min}$
- b) Constant frequency: 3 khz, 30 seconds
- c) Ambient Levels: 30 seconds

Part 2

- a) Frequency: 2 khz to 6 KHz sweep  
J9 Current: 0.5 amperes  
Sweep rate:  $\frac{(1.5 \times 1 \text{ ipm})}{2 \text{ in/KHz}} \approx 750 \text{ hz/min}$
- b) Constant frequency: 6 khz, 30 seconds
- c) Ambient levels: 30 seconds

Part 3

- a) Frequency: 5 khz to 20 khz sweep  
J9 current: 0.2 amperes (0.3 amperes initially)  
Sweep rate:  $\frac{(0.5 \times 10 \text{ ipm})}{2 \text{ in/KHz}} = 2.5 \text{ khz/min}$
- b) Constant frequency: 5 khz, 30 seconds
- c) Ambient levels: 30 seconds

FIGURE 5-9 OVERSIDE CALIBRATION RANGES

COPY AVAILABLE TO DOG DOES NOT  
PERMIT FULLY LEGIBLE PRODUCTION

FIGURE 5-10a. OVERSIDE CALIBRATION GEOMETRY FOR STATION 1

RECEIVER	POSITION 1			POSITION 2			POSITION 3			POSITION 4		
	R TO T LENGTH	COMEN ANGLE	R TO T LENGTH	COMEN ANGLE	R TO T LENGTH	COMEN ANGLE	R TO T LENGTH	COMEN ANGLE	R TO T LENGTH	COMEN ANGLE	R TO T LENGTH	COMEN ANGLE
HF1	10° 9.891**	59.229	12° 1.526**	20.095	22° 2.407**	34.708	33° 4.369**	42.459	33° 4.369**	42.459	33° 3.286**	41.155
HF2	10° 6.511**	58.897	11° 10.518**	15.222	22° 0.857**	32.968	33° 2.512**	40.977	33° 2.512**	40.977	33° 2.512**	40.977
HF3	10° 4.049**	58.083	11° 8.336**	11.022	21° 11.689**	32.481	31° 1.448	30.404**	31° 1.448	30.404**	31° 1.448	30.404**
HF4	10° 2.529**	58.502	11° 6.975**	6.467	21° 10.978**	21° 10.978**	21° 10.978**	21° 10.978**	21° 10.978**	21° 10.978**	21° 10.978**	21° 10.978**
HF5	10° 1.974**	59.237	11° 6.506**	2.380	21° 10.720**	29.976	33° 1.871**	38.778	33° 1.871**	38.778	33° 1.871**	38.778
HF6	10° 1.878**	59.298	11° 6.421**	3.034	21° 10.675**	30.028	33° 1.864**	38.809	33° 1.864**	38.809	33° 1.864**	38.809
HF7	10° 2.817**	60.534	11° 7.249**	6.709	21° 11.112**	29.191	33° 2.131**	37.958	33° 2.131**	37.958	33° 2.131**	37.958
HF8	10° 4.598**	62.038	11° 8.222**	11.152	21° 11.594**	26.931	33° 2.664**	36.999	33° 2.664**	36.999	33° 2.664**	36.999
HF9	10° 7.063**	63.958	11° 11.008**	14.792	22° 1.121**	27.545	33° 3.461**	35.622	33° 3.461**	35.622	33° 3.461**	35.622
HF10	8° 1.257**	30.746	12° 4.815**	50.807	23° 10.040**	51.074	35° 4.508**	57.547	35° 4.508**	57.547	35° 4.508**	57.547
HF11	8° 8.301**	41.679	11° 11.472**	21.050	23° 1.053**	43.905	34° 6.616**	51.081	34° 6.616**	51.081	34° 6.616**	51.081
HF12	9° 3.970**	48.415	11° 8.683**	13.968	22° 6.350**	39.193	33° 10.907**	47.073	33° 10.907**	47.073	33° 10.907**	47.073
HF13	11° 1.727**	67.154	11° 6.832**	9.087	21° 4.303**	22.353	32° 5.619**	32° 5.619**	32° 5.619**	32° 5.619**	32° 5.619**	32° 5.619**
LF1	47° 7.106**	90.638	47° 7.599**	78.475	50° 10.058**	65.219	56° 4.301**	56° 4.301**	56° 4.301**	56° 4.301**	56° 4.301**	56° 4.301**
LF2	50° 0.362**	90.627	50° 0.728**	79.061	53° 1.340**	66.367	58° 4.933**	58° 4.933**	58° 4.933**	58° 4.933**	58° 4.933**	58° 4.933**
LF3	52° 5.609**	52° 1.185	52° 6.109**	79.962	55° 5.252**	67.554	60° 6.529**	60° 6.529**	60° 6.529**	60° 6.529**	60° 6.529**	60° 6.529**
LF4	57° 10.675**	91.493	57° 10.675**	81.223	60° 6.193**	69.724	65° 2.277**	60° 3.268	65° 2.277**	60° 3.268	65° 2.277**	60° 3.268
LF5	60° 4.084**	91.513	60° 4.313**	81.602	62° 10.852**	70.468	67° 5.174**	61.338	67° 5.174**	61.338	67° 5.174**	61.338
LF6	63° 0.561**	91.529	63° 0.780**	81.989	65° 6.059**	71.230	69° 10.361**	55.121	69° 10.361**	55.121	69° 10.361**	55.121
LF7	65° 6.186**	91.620	65° 6.418**	82.390	67° 10.656**	71.948	72° 1.252**	56.523	72° 1.252**	56.523	72° 1.252**	56.523
LF8	68° 2.814**	91.706	68° 2.854**	82.845	70° 5.686**	72.787	74° 6.458**	57.766	74° 6.458**	57.766	74° 6.458**	57.766
LF9	54° 0.865**	86.880	54° 1.145**	79.554	58° 6.615**	71.934	64° 4.281**	66.326	64° 4.281**	66.326	64° 4.281**	66.326
LF10	54° 2.207**	85.765	54° 9.956**	77.275	58° 3.704**	68.305	63° 8.985**	61.590	63° 8.985**	61.590	63° 8.985**	61.590
LF11	54° 4.414**	87.127	54° 9.119**	77.588	57° 11.571**	67.521	63° 2.364**	59.353	63° 2.364**	59.353	63° 2.364**	59.353
LF12	54° 7.475**	89.305	54° 9.644**	79.000	57° 9.707**	67.669	62° 9.869**	58.745	62° 9.869**	58.745	62° 9.869**	58.745
LF13	55° 3.355**	92.383	55° 2.281**	91.453	57° 10.067**	69.213	62° 7.519**	59.137	62° 7.519**	59.137	62° 7.519**	59.137
G1	65° 5.658**	83.546	66° 7.285**	79.071	70° 2.014**	74.449	75° 3.913**	70.989	75° 3.913**	70.989	75° 3.913**	70.989
G2	66° 1.657**	83.554	67° 3.148**	79.122	70° 9.481**	74.534	75° 10.785**	71.087	75° 10.785**	71.087	75° 10.785**	71.087
G3	70° 6.143**	83.985	71° 6.830**	79.813	74° 10.754**	75.430	79° 9.009**	72.058	79° 9.009**	72.058	79° 9.009**	72.058
G4	71° 2.142**	83.989	72° 2.712**	79.853	75° 6.288**	75.502	80° 4.089**	72.145	80° 4.089**	72.145	80° 4.089**	72.145
G5	65° 10.414**	80.318	66° 8.347**	74.454	69° 10.977**	68.298	74° 9.592**	63.615	74° 9.592**	63.615	74° 9.592**	63.615
G6	66° 6.365**	80.365	67° 4.200**	74.558	70° 6.472**	68.449	75° 4.592**	63.786	75° 4.592**	63.786	75° 4.592**	63.786
G7	70° 6.028**	85.228	71° 3.295**	79.705	74° 3.226**	73.737	78° 10.886**	69.001	78° 10.886**	69.001	78° 10.886**	69.001
G8	71° 2.027**	85.265	71° 1.209**	79.731	74° 11.121**	73.740	79° 6.020**	68.969	79° 6.020**	68.969	79° 6.020**	68.969
G9	67° 9.149**	84.710	69° 8.523**	81.063	72° 10.334**	77.307	78° 1.172**	74.485	78° 1.172**	74.485	78° 1.172**	74.485
G10	68° 5.138**	84.707	69° 9.356**	61.167	73° 5.768**	77.517	78° 8.112**	74.770	78° 8.112**	74.770	78° 8.112**	74.770
H1	44° 5.471**	89.849	44° 6.733**	77.034	48° 0.541**	63.289	53° 10.924**	53.145	53° 10.924**	53.145	53° 10.924**	53.145
H2	71° 8.393**	87.458	72° 2.167**	79.540	74° 10.182**	70.689	79° 1.825**	73.322	79° 1.825**	73.322	79° 1.825**	73.322
H3	71° 10.953**	89.778	72° 1.158**	61.556	74° 5.170**	72.256	78° 5.537**	64.412	78° 5.537**	64.412	78° 5.537**	64.412
H4	72° 5.574**	92.860	72° 4.678**	84.304	74° 5.061**	74.523	78° 2.332**	66.166	78° 2.332**	66.166	78° 2.332**	66.166
H5	97° 0.884**	91.462	97° 1.169**	85.120	98° 8.559**	77.800	101° 8.041**	71.341	101° 8.041**	71.341	101° 8.041**	71.341
H6	104° 7.570**	91.521	104° 8.862**	85.876	106° 4.047**	79.363	109° 2.124**	73.596	109° 2.124**	73.596	109° 2.124**	73.596
H7	113° 0.923**	90.008	113° 2.911**	84.719	114° 9.592**	78.608	117° 6.046**	73.170	117° 6.046**	73.170	117° 6.046**	73.170
H8	124° 1.041**	90.550	124° 2.153**	85.674	125° 6.395**	80.018	127° 11.392**	74.945	127° 11.392**	74.945	127° 11.392**	74.945
H9	113° 3.663**	91.541	113° 3.262**	86.106	114° 7.903**	79.755	117° 2.266**	74.515	117° 2.266**	74.515	117° 2.266**	74.515
H10	113° 7.342**	97.084	113° 6.649**	86.596	114° 10.180**	80.223	117° 3.810**	74.016	117° 3.810**	74.016	117° 3.810**	74.016

## OVERSIDE CALIBRATION GEOMETRY FOR STATION 2

8/23/66

PAGE 2

RECEIVER	POSITION 1			POSITION 2			POSITION 3			POSITION 4		
	R TO Y LENGTH	COMEN ANGLE	R TO T LENGTH	COMEN ANGLE	R TO Y LENGTH	COMEN ANGLE	R TO T LENGTH	COMEN ANGLE	R TO Y LENGTH	COMEN ANGLE	R TO T LENGTH	COMEN ANGLE
HF1	16° 11.662**	69.124	17° 10.677**	46.090	26° 0.855**	42.258	36° 2.611**	44.899				
HF2	16° 3.306**	68.459	17° 2.766**	43.438	25° 7.480**	40.128	35° 10.780**	43.293				
HF3	15° 7.641**	67.456	16° 7.542**	41.100	25° 2.670**	38.966	35° 7.337**	42.759				
HF4	15° 0.322**	67.097	16° 0.676**	38.544	24° 10.188**	37.067	35° 4.174**	41.343				
HF5	14° 5.989**	66.870	15° 6.762**	36.080	24° 6.401**	35.251	35° 1.521**	39.977				
HF6	13° 11.075**	66.069	15° 0.339**	33.508	24° 2.369**	34.310	34° 10.715**	39.640				
HF7	13° 5.330**	65.945	14° 7.029**	30.762	23° 11.101**	32.516	34° 8.456**	38.319				
HF8	12° 11.348**	65.844	14° 1.532**	27.605	23° 7.783**	30.659	34° 6.175**	36.999				
HF9	12° 7.180**	66.354	13° 9.720**	24.932	23° 5.523**	28.508	34° 4.630**	35.235				
HF10	12° 10.771**	55.407	16° 45.581	26° 31.165**	26° 53.377	37° 2.959**	37° 58.087					
HF11	13° 4.179**	58.883	15° 10.088**	40.920	26° 7.054**	46.961	36° 5.217**	51.793				
HF12	13° 10.108**	61.219	15° 8.160**	38.341	25° 1.110**	42.833	35° 9.976**	47.872				
HF13	15° 3.481**	71.615	15° 7.364**	36.594	24° 0.904**	29.798	34° 5.890**	33.966				
LF1	39° 5.811	90.811	39° 6.380**	74.806	43° 5.940**	59.325	49° 11.488**	48.488				
LF2	61° 10.416**	90.789	41° 10.844**	75.710	45° 7.832**	60.943	51° 10.058**	50.329				
LF3	44° 3.125**	91.486	44° 3.701**	76.985	47° 10.603**	62.606	53° 9.895**	51.973				
LF4	49° 7.327**	91.852	49° 7.267**	78.798	52° 9.297**	65.585	58° 2.137**	55.379				
LF5	52° 0.354**	91.881	52° 0.583**	79.367	55° 1.223**	66.629	60° 3.812**	56.638				
LF6	54° 8.470**	91.919	54° 8.689**	79.952	57° 7.630**	67.694	62° 7.692**	57.934				
LF7	57° 1.824**	92.027	57° 2.080**	80.513	59° 11.604**	68.660	64° 9.531**	59.109				
LF8	59° 10.179**	92.094	59° 10.179**	81.101	62° 6.054**	69.728	67° 1.594**	60.458				
LF9	45° 5.394**	65.687	46° 7.212**	76.282	51° 1.233**	67.786	57° 7.172**	62.079				
LF10	45° 7.599**	86.890	46° 5.502**	73.955	50° 7.836**	63.820	56° 11.234**	56.862				
LF11	45° 10.882**	66.672	46° 4.862**	74.380	50° 3.388**	62.594	56° 4.088**	54.179				
LF12	46° 3.211**	89.271	46° 7.928**	76.020	50° 1.132**	62.973	55° 11.404**	53.338				
LF13	47° 1.858**	92.900	47° 0.425**	78.935	50° 3.010**	64.807	55° 9.627**	53.996				
G1	56° 8.872**	62.447	58° 1.844**	76.897	62° 3.754**	71.873	68° 1.885**	68.380				
G2	57° 4.867**	82.469	58° 9.647**	76.978	62° 11.042**	71.991	68° 8.553**	68.504				
G3	61° 9.192**	83.037	63° 0.836**	77.906	66° 11.113**	73.135	72° 4.807**	69.680				
G4	62° 5.189**	63.051	63° 8.670**	77.972	67° 6.500**	73.235	72° 11.646**	69.790				
G5	57° 4.555**	78.861	58° 4.862**	71.541	62° 2.011**	64.792	67° 8.424**	59.986				
G6	59° 0.462**	78.930	59° 0.632**	71.711	62° 9.316**	64.995	58° 3.137**	60.201				
G7	61° 9.316**	84.557	62° 8.738**	77.731	66° 2.921**	71.132	71° 5.534**	66.152				
G8	52° 5.315**	64.611	63° 4.614**	77.780	66° 10.384**	71.155	72° 0.496**	66.131				
G9	53° 11.655**	83.775	60° 7.968**	79.288	64° 11.953**	75.236	70° 10.815**	72.395				
G10	54° 7.445**	83.777	61° 3.740**	79.427	65° 7.212**	75.493	71° 5.475**	72.726				
G11	45° 6.577**	89.860	36° 0.632**	72.754	40° 10.350**	56.654	47° 8.980**	45.944				
G12	46° 1.405**	87.335	63° 8.480**	77.563	66° 9.804**	67.654	71° 8.264**	59.681				
G13	63° 4.710**	89.952	63° 7.579**	79.811	66° 4.404**	69.362	70° 11.309**	60.814				
G14	64° 1.539**	93.432	64° 0.393**	82.914	66° 5.067**	71.919	70° 8.500**	62.771				
G15	59° 5.871**	91.789	88° 6.176**	84.225	90° 4.306**	76.204	93° 7.730**	69.225				
G16	55° 11.587**	91.666	96° 1.087**	84.977	97° 10.799**	77.883	101° 0.639**	71.684				
G17	57° 4.607**	90.154	104° 6.918**	83.926	106° 3.892**	77.309	109° 3.524**	71.486				
G18	53° 4.643**	90.726	115° 5.911**	85.026	117° 0.055**	78.940	119° 7.722**	73.530				
G19	54° 8.386**	91.876	104° 8.284**	85.436	106° 2.667**	78.559	109° 0.028**	72.471				
G20	51° 1.071**	92.398	105° 0.165**	85.947	106° 5.699**	79.051	109° 2.263**	72.935				

FIGURE 5-10b. OVERSIDE CALIBRATION GEOMETRY

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## OVERSIDE CALIBRATION GEOMETRY FOR STATION 3

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RECEIVER	POSITION 1			POSITION 2			POSITION 3			POSITION 4		
	R TO T LENGTH	COHEN ANGLE										
HF1	59° 7.516**	82.011	60° 4.818**	74.668	63° 4.949**	79.638	69° 0.004**	65.190	69° 6.38	68.65	66° 2.242	66.248
HF2	58° 8.196**	81.786	59° 5.646**	74.111	62° 6.315**	68.65	66° 5.094**	63.917	66° 5.45	68.020	66° 7.993**	63.208
HF3	57° 9.545**	81.639	58° 7.138**	73.847	61° 8.328**	10.370**	67° 1.338**	6.376**	66° 6.517	11.756**	66° 6.517	62.522
HF4	56° 10.906**	81.673	57° 8.646**	73.545	60° 10.370**	1.338**	67° 3.311**	3.311**	65° 6.419	6.612	65° 2.631**	62.398
HF5	56° 1.238**	81.726	56° 11.116**	73.266	60° 6.232**	59°	66° 6.269**	6.269**	66° 6.912	6.412	66° 6.422**	61.705
HF6	55° 2.483**	81.827	56° 0.519**	73.235	59° 3.511**	6.235**	66° 6.300**	6.300**	66° 6.378	9.394**	66° 6.378	60.981
HF7	54° 4.764**	81.897	55° 2.947**	72.959	58° 6.269**	6.269**	66° 6.128	6.128	66° 6.786	6.786	66° 6.114	60.114
HF8	53° 6.028**	81.974	54° 4.379**	72.667	57° 8.300**	7.300**	66° 6.255**	6.255**	66° 7.164	7.164	66° 5.335**	71.830
HF9	52° 9.355**	82.157	53° 7.845**	72.394	57° 9.706**	9.706**	66° 7.060**	7.060**	66° 7.599	7.599	66° 6.244**	68.354
HF10	55° 7.575**	81.821	57° 1.610**	77.100	60° 6.282**	6.282**	66° 7.923**	7.923**	66° 7.002	7.002	66° 4.293**	66.242
HF11	55° 9.097**	81.629	57° 0.236**	75.533	60° 7.491	7.491	66° 11.412**	11.412**	66° 6.128	6.128	66° 7.826**	60.209
HF12	55° 10.852**	81.333	56° 1.602**	74.491	60° 3.923**	3.923**	66° 6.593**	6.593**	66° 2.012	2.012	66° 6.593**	12.380
HF13	56° 4.267**	82.301	56° 11.306**	72.767	59° 11.412**	11.412**	66° 20.162	20.162	66° 6.593**	6.593**	66° 3.77	6.377
LF1	17° 2.396**	86.048	18° 10.013**	40.228	26° 5.593**	5.593**	36° 9.729**	9.729**	36° 14.283	14.283	36° 10.322**	8.640
LF2	16° 2.680**	85.873	17° 11.063**	36.739	25° 5.663**	5.663**	36° 1.537	1.537	36° 15.846	15.846	36° 4.667	4.667
LF3	15° 7.103**	87.876	17° 4.751**	36.288	25° 4.380**	4.380**	38° 31.4	31.4	38° 8.596**	8.596**	38° 4.979	4.979
LF4	15° 8.963**	89.827	17° 4.447**	38.314	25° 10.323**	10.323**	19° 3.079	3.079	19° 1.161**	1.161**	19° 8.801	8.801
LF5	16° 4.418**	90.361	18° 0.236**	41.166	25° 10.805	10.805	23° 7.70	7.70	23° 7.069**	7.069**	23° 12.925	12.925
LF6	17° 5.463**	91.142	19° 0.151**	45.175	26° 6.739**	6.739**	26° 2.76	2.76	26° 6.786	6.786	26° 6.786	16.718
LF7	18° 9.297**	91.772	20° 2.859**	49.110	27° 5.480**	5.480**	28° 1.119	1.119	28° 5.276	5.276	28° 0.923**	0.923**
LF8	20° 5.588**	91.892	21° 9.043**	52.797	28° 6.650**	6.650**	32° 11.937**	11.937**	32° 3.56	3.56	32° 10.322**	8.640
LF9	8° 7.521**	45.905	16° 0.329**	18.196	26° 5.623**	5.623**	31° 6.13	6.13	31° 6.13	6.13	31° 11.949**	11.949**
LF10	10° 0.577**	59.825	15° 8.661**	5.270	25° 8.783**	8.783**	20° 7.31	7.31	20° 7.31	7.31	20° 4.901**	4.901**
LF11	11° 8.641**	72.266	15° 8.716**	10.805	25° 2.040**	2.040**	8.807	8.807	3.169**	3.169**	17° 6.15	17° 6.15
LF12	13° 6.842**	81.910	16° 2.940**	24.594	25° 2.076	2.076	3.661	3.661	3.661	3.661	7.268	7.268
LF13	17° 2.758**	91.827	18° 4.502**	43.898	25° 10.378**	10.378**	20° 8.05	8.05	36° 1.356	1.356	36° 10.872**	8.054
G1	13° 2.867**	56.349	20° 7.677**	46.318	30° 4.739**	4.739**	49° 4.94	4.94	42° 31.613	31.613	42° 5.844**	5.844**
G2	13° 9.888**	57.626	21° 0.238**	47.055	30° 7.852**	7.852**	49° 7.46	7.46	42° 20.731	20.731	42° 8.075**	52.443
G3	17° 7.462**	23° 8.367**	32° 52.930	32° 6.628**	52° 5.299	5.299	52° 6.28	6.28	52° 5.875	5.875	52° 4.711	52° 4.711
G4	18° 3.077**	65.971	24° 2.022**	53.575	32° 10.763**	10.763**	52° 9.13	9.13	44° 3.773**	3.773**	44° 5.110**	54.011
G5	17° 7.491**	50.684	22° 6.594**	26.989	31° 0.659**	0.659**	28° 9.52	9.52	42° 28.952	28.952	42° 4.877**	33.949
G6	18° 0.815**	51.593	22° 10.775**	28.349	31° 3.705**	3.705**	29° 5.667	5.667	42° 30.567	30.567	42° 7.112**	34.181
G7	17° 8.032**	80.475	22° 6.936**	48.597	31° 8.012**	8.012**	44° 6.687	6.687	42° 44.633	44.633	42° 4.987	44.664
G8	18° 3.558**	71.131	23° 0.866**	49.310	31° 5.192**	5.192**	44° 8.62	8.62	42° 10.863	10.863	42° 8.168**	23.860
G9	14° 7.455**	64.858	22° 7.753**	57.674	32° 4.665**	4.665**	58.781	58.781	44° 9.815**	9.815**	44° 5.110**	60.205
G10	15° 2.999**	65.700	23° 0.683**	58.471	32° 8.128**	8.128**	59.382	59.382	44° 5.110**	5.110**	44° 4.640**	60.205
H1	18° 5.451**	84.692	20° 2.096**	43.296	27° 6.540**	6.540**	24.945	24.945	42° 4.877**	4.877**	42° 4.839**	17.581
H2	20° 8.987**	80.384	23° 11.804**	46.595	31° 5.376**	5.376**	31.427	31.427	42° 4.987	4.987	42° 1.598**	23.905
H3	21° 10.819**	87.384	23° 10.041**	52.422	30° 7.401**	7.401**	34.365	34.365	40° 10.863	10.863	40° 10.863	23.860
H4	24° 6.957**	95.519	25° 4.464**	62.236	31° 2.531**	2.531**	42.346	42.346	40° 9.815**	9.815**	40° 5.110**	28.757
H5	44° 9.098**	92.167	45° 4.968**	74.145	32° 0.963**	0.963**	61.274	61.274	55° 10.766	10.766	55° 4.954	60.205
H6	51° 6.079**	90.836	52° 3.716**	75.853	55° 8.285**	8.285**	65.017	65.017	61° 10.903**	10.903**	61° 54.832	54.832
H7	59° 8.320**	89.434	60° 6.600**	76.340	63° 7.393**	7.393**	66.690	66.690	69° 3.025**	3.025**	69° 57.249	57.249
H8	70° 7.050**	90.417	71° 2.158**	79.188	73° 8.440**	8.440**	70.709	70.709	62° 6.131**	6.131**	62° 62.064	62.064
H9	60° 6.822**	92.211	60° 11.981**	78.777	63° 8.736**	8.736**	68.708	68.708	69° 0.314**	0.314**	69° 58.681	58.681
H10	61° 6.241**	92.828	61° 9.797**	79.519	64° 4.977**	4.977**	69.489	69.489	69° 6.715**	6.715**	69° 59.434	59.434

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FIGURE 5-10c OVERSIDE CALIBRATION GEOMETRY

RECEIVER	POSITION 1			POSITION 2			POSITION 3			POSITION 4		
	R TO T LENGTH	COHEN ANGLE										
HF1	73° 4.538"	83.652	73° 9.221"	78.266	76° 8.300"	73.001	81° 5.910"	68.920				
HF2	72° 5.096"	83.448	72° 11.139"	71.836	75° 9.358"	72.356	80° 7.620"	68.120				
HF3	71° 6.336"	83.350	71° 0.446"	77.490	74° 11.080"	72.132	79° 9.967"	67.873				
HF4	70° 7.583"	83.400	71° 2.727"	77.330	74° 0.820"	71.733	79° 0.344"	67.309				
HF5	69° 9.807"	83.465	70° 3.934"	77.401	73° 3.502"	71.354	78° 3.617"	66.766				
HF6	68° 10.950"	83.613	69° 6.127"	77.248	72° 5.167"	71.358	77° 5.950"	66.735				
HF7	68° 2.279"	83.692	68° 6.170"	77.266	71° 7.826"	70.980	76° 9.225"	66.189				
HF8	67° 83.779	67° 7.390"	70° 77.091	70° 9.524"	70.587	75° 11.618"	65.624					
HF9	66° 5.494"	83.946	66° 10.661"	76.951	70° 1.190"	70.138	75° 3.857"	64.935				
HF10	69° 4.994"	84.005	70° 3.809"	80.513	73° 10.553"	77.284	79° 3.420"	74.939				
HF11	69° 6.299"	83.697	70° 3.018"	79.230	73° 7.666"	75.012	78° 10.876"	71.882				
HF12	69° 7.789"	83.318	70° 2.783"	78.329	73° 5.678"	73.571	78° 7.495"	70.006				
HF13	70° 0.359"	83.820	70° 3.231"	76.927	73° 1.883"	70.106	78° 0.271"	64.776				
LF1	26° 10.605"	87.840	27° 4.534"	62.025	34° 6.212	43° 5.031	30.500					
LF2	24° 10.802"	87.709	25° 5.003"	59.696	32° 6.218"	37.985	42° 2.283"	27.586				
LF3	23° 0.221"	88.950	23° 7.261"	58.096	31° 0.708"	34.955	41° 1.901"	24.309				
LF4	19° 6.157"	90.345	20° 0.889"	53.077	28° 6.446"	27.466	39° 1.244"	17.227				
LF5	18° 2.199"	91.860	18° 10.272"	50.549	27° 6.900"	24.064	38° 6.786"	13.921				
LF6	17° 0.468"	91.834	17° 9.062"	48.422	26° 10.011"	20.985	38° 0.473"	10.621				
LF7	16° 4.496"	92.735	17° 1.518"	47.289	26° 5.137"	19.128	37° 9.090"	8.245				
LF8	16° 0.539"	93.054	16° 8.866"	46.400	26° 1.540"	17.672	37° 6.190"	6.238				
LF9	16° 9.117"	69.218	20° 5.479"	45.919	30° 8.820"	41.213	42° 2.881	42.002				
LF10	17° 7.196"	75.102	20° 4.409"	46.451	30° 1.198"	36.258	41° 4.673"	35.301				
LF11	18° 8.018"	80.567	20° 6.299"	46.092	29° 7.459"	31.791	40° 7.741"	28.183				
LF12	19° 11.461"	85.453	21° 0.772"	51.499	29° 6.093"	30.090	40° 4.723"	22.879				
LF13	22° 8.661"	91.595	22° 11.436"	59.263	30° 3.228"	34.162	40° 4.297"	22.036				
G1	7° 6.318"	31.242	15° 11.760"	37.745	29° 1.347"	48.427	41° 9.754"	52.384				
G2	7° 4.031"	27.604	15° 10.723"	36.936	29° 0.763"	48.167	41° 9.348"	52.234				
G3	7° 0.844"	23.888	15° 9.377"	36.611	29° 0.088"	48.164	41° 8.918"	52.258				
G4	7° 4.312"	27.166	15° 10.850"	36.808	29° 0.892"	48.108	41° 9.476"	52.194				
G5	14° 2.764"	43.430	18° 9.766"	12.893	29° 16.986"	25.696	41° 9.757"	33.267				
G6	14° 1.565"	42.655	18° 8.841"	10.948	29° 10.418"	25.247	41° 9.350"	33.051				
G7	11° 3.553"	45.928	14° 3.443"	22.951	27° 3.507"	36.739	39° 11.698"	41.447				
G8	11° 6.502"	47.677	14° 5.068	23.169	27° 4.361"	36.241	40° 0.282"	40.902				
G9	11° 4.312"	11.220	16° 5.653"	50.009	30° 2.004"	57.340	43° 0.721"	59.943				
G10	5° 4.936"	7.897	16° 5.653"	50.208	30° 2.026"	57.688	43° 0.737"	60.339				
H1	2° 2.766"	87.100	29° 9.593"	63.893	36° 1.027"	44.716	45° 1.698"	34.333				
H2	1° 3.300"	76.302	15° 11.401"	23.824	27° 3.341"	5.012	39° 4.416"	9.229				
H3	1° 2.966"	87.537	16° 0.126"	31.223	26° 3.624"	10.997	38° 0.497"	3.849				
H4	1° 3.142"	97.856	18° 6.236"	56.506	27° 0.684"	27.825	37° 11.788"	15.336				
H5	11° 0.133"	93.532	16° 4.172"	10.732	38° 1.595"	40.437	46° 8.767"	31.792				
H6	3° 0.107"	91.208	18° 8.175"	12.959	43° 10.700"	56.219	51° 8.904"	45.071				
H7	4° 2.246"	89.754	46° 8.830"	74.501	51° 3.835"	59.914	58° 3.925"	49.327				
H8	5° 9.873"	70.859	57° 3.066"	73.342	60° 10.844"	65.808	66° 9.448"	55.956				
H9	4° 7.134"	47° 5.344"	52° 6.739	51° 5.944"	52° 6.376	58° 1.072"	51.026	51.955				
H10	4° 3.759"	5.959"	48° 6.806"	78.572	52° 4.606"	63.455	58° 9.130"	51.955				

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FIGURE 5-10d OVERSIDE CALIBRATION GEOMETRY

## OVERSIDE CALIBRATION GEOMETRY FOR STATION 5

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RECEIVER	POSITION 1			POSITION 2			POSITION 3			POSITION 4		
	R TO T LENGTH	COHEN ANGLE										
HF1	114°	11.307°*	86.176	115°	3.139°*	82.480	117°	3.162°*	78.936	120°	10.374°*	75.666
HF2	113°	11.708°*	85.981	114°	3.572°*	82.149	116°	3.794°*	78.476	119°	11.348°*	75.090
HF3	113°	0.812°*	85.939	113°	4.707°*	82.076	115°	5.119°*	78.376	119°	0.998°*	74.970
HF4	112°	1.948°*	85.990	112°	5.845°*	81.991	114°	6.450°*	78.160	118°	2.659°*	74.633
HF5	111°	4.013°*	86.048	111°	7.968°*	81.916	113°	8.751°	77.955	117°	5.264°*	74.308
HF6	110°	5.042°*	86.247	110°	9.030°*	82.081	112°	10.014°*	78.089	116°	6.869°*	74.416
HF7	109°	7.099°*	86.313	109°	11.117°*	82.012	112°	0.285°*	77.888	115°	9.454°*	74.093
HF8	108°	8.131°*	86.386	109°	1.182°*	81.945	111°	1.557°*	77.685	114°	11.077°*	73.767
HF9	107°	11.216°*	86.503	108°	3.296°*	81.877	110°	4.840°*	77.437	114°	2.650°*	73.348
HF10	111°	0.731°*	87.334	111°	8.665°*	84.948	114°	1.321°*	82.694	118°	1.443°*	80.653
HF11	111°	1.626°*	86.821	111°	8.164°*	83.791	113°	11.430°*	80.914	117°	10.281°*	78.294
HF12	111°	2.643°*	86.307	111°	7.982°*	82.334	113°	10.149°*	79.724	117°	7.943°*	76.793
HF13	111°	5.743°*	86.050	111°	8.315°*	81.413	113°	7.738°*	76.942	117°	2.970°*	72.798
LF1	65°	10.777°*	89.161	66°	2.460°*	78.054°*	69°	4.738°*	67.601	75°	1.214°*	58.551
LF2	63°	5.749°*	89.145	63°	9.490°*	77.611	67°	1.068°*	66.803	72°	11.638°*	57.538
LF3	61°	0.814°*	89.580	61°	4.843°*	77.368	64°	10.015°*	65.963	70°	10.956°*	56.258
LF4	55°	10.081°*	90.108	56°	1.894°*	76.606	59°	10.126°*	64.119	66°	4.068°*	53.741
LF5	53°	5.511°*	90.284	53°	9.818°*	76.096	57°	8.151°*	63.063	64°	4.990°*	52.374
LF6	50°	10.281°*	90.688	51°	2.807°*	75.687	55°	3.309°*	62.010	62°	3.275°*	50.966
LF7	48°	6.243°*	88.979	48°	11.022°*	75.191	53°	1.673°*	60.085	60°	4.644°*	49.513
LF8	45°	11.520°*	91.068	46°	4.221°*	74.361	50°	9.129°*	59.389	58°	3.387°*	47.734
LF9	57°	0.012°*	84.014	58°	4.634°*	75.266	62°	11.217°*	67.824	70°	0.395°*	62.202
LF10	57°	3.510°*	86.789	58°	4.461°*	76.681	62°	7.711°*	67.782	69°	6.231°*	60.791
LF11	57°	8.100°*	88.124	58°	5.383°*	76.791	62°	5.215°*	66.572	69°	0.948°*	58.307
LF12	58°	1.823°*	88.979	58°	8.055°*	76.743	62°	4.917°*	65.508	68°	10.141°*	56.207
LF13	59°	3.117°*	90.340	59°	5.446°*	77.006	62°	10.170°*	65.283	68°	11.639°*	54.966
G1	45°	3.884°*	85.243	47°	8.990°*	77.372	53°	9.967°*	71.457	62°	6.119°*	67.621
G2	44°	8.039°*	80.088	47°	1.549°*	77.121	53°	3.376°*	71.184	62°	0.450°*	67.375
G3	40°	3.319°*	84.603	42°	11.894°*	75.906	49°	7.940°*	69.799	58°	11.525°*	66.162
G4	39°	7.492°*	84.418	42°	4.570°*	75.607	49°	1.611°*	69.490	58°	6.202°*	65.899
G5	47°	1.979°*	80.251	48°	11.784°*	70.183	54°	5.526°*	62°	7.765°*	57.300	
G6	46°	6.444°*	80.046	48°	4.533°*	69.052	53°	9.967°*	62°	2.109°*	56.957	
G7	40°	3.961°*	86.172	42°	5.249°*	74.407	48°	7.865°*	65.570	57°	8.034°*	59.996
G8	39°	8.146°*	86.065	41°	9.827°*	73.991	48°	1.403°*	64.989	57°	2.591°*	59.366
G9	42°	9.710°*	86.621	45°	10.568°*	79.682	52°	7.507°*	74.671	61°	10.244°*	71.520
G10	42°	1.816°*	86.497	45°	3.210°*	79.617	52°	1.103°*	74.708	61°	4.802°*	71.657
G11	68°	9.796°*	88.965	69°	1.955°*	78.514	72°	3.271°*	68.659	77°	9.779°*	60.065
G12	40°	8.439°*	87.631	42°	2.299°*	70.238	47°	10.937°*	55.918	56°	7.128°*	45.833
G13	41°	4.930°*	90.064	42°	2.847°*	72.040	47°	4.591°*	56.584	55°	7.941°*	45.283
G14	43°	1.351°*	93.071	43°	4.386°*	74.780	47°	10.804°*	58.429	55°	8.166°*	45.896
G15	20°	2.416°*	96.301	21°	2.420°*	57.486	29°	8.569°*	32.084	41°	3.985°*	20.863
G16	13°	2.450°*	91.246	15°	5.327°*	35.188	26°	4.282°*	12.897	39°	3.349°*	9.307
G17	11°	3.463°*	92.319	14°	6.127°*	28.264	26°	2.226°*	6.489	39°	4.868°*	5.C11
G18	17°	8.286°*	94.427	19°	5.215°*	51.784	28°	10.643°*	28.397	41°	0.322°*	18.967
G19	15°	11.851°*	99.836	17°	0.257°*	49.794	26°	9.065°*	22.567	39°	1.992°*	11.157
G10	19°	9.274°*	98.168	20°	2.959°*	57.853	28°	7.813°*	30.993	40°	3.563°*	17.893

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FIGURE 5-10e OVERSIDE CALIBRATION GEOMETRY

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## SECTION VI

ACOUSTIC DATA

## A. DISCUSSION OF NOISE MEASUREMENTS

We discuss salient features of the available results, make comparisons with previous results, and provide some theoretical orientation. The present discussion is based only on the following data from PURVIS II: noise measurements from 0.5 to 5 kc for flush elements G1, G8, and recessed elements G3, G5, all in Sea Chest 2, and flush element G10 in the hull nearby, and from 0 to 10 kc for all D elements in Sea Chest 1; overside (in-situ) calibrations for all D and G elements and a frequency-independent intrinsic (free-field) sensitivity for the D elements. No free-field calibrations were available for the G elements.

The D elements are covered by layers of thicknesses given below. The layers covering elements D1, D5, D6, and D10 are planar, and those covering the others are of limited lateral extent corresponding to a 60° conical divergence from the element periphery to the outer surface, merging, however, into a planar layer of thickness 1/2".

Element	D1	D2	D3	D4	D5	D6
Thickness (in.)	1-5/32	1-47/64	2-51/64	4-59/64	5/8	13/16

Element	D7	D8	D9	D10
Thickness (in.)	1-23/32	2-25/32	5-1/32	59/64

1. Results for G elements (Figures 6-1 to 6-8)

Because of a decided change in character of these noise spectra above 3 kc, we discuss first the interval 0.5 to 3 kc. For flush window-mounted elements G1 and G8 the dependence

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SEA CHEST NUMBER II  
ELEMENT NO. G1 (FLUSH)  
A 5 KNOTS, RUN 344  
B 10 KNOTS, RUN 345  
C 15 KNOTS, RUN 346  
D 20 KNOTS, RUN 347

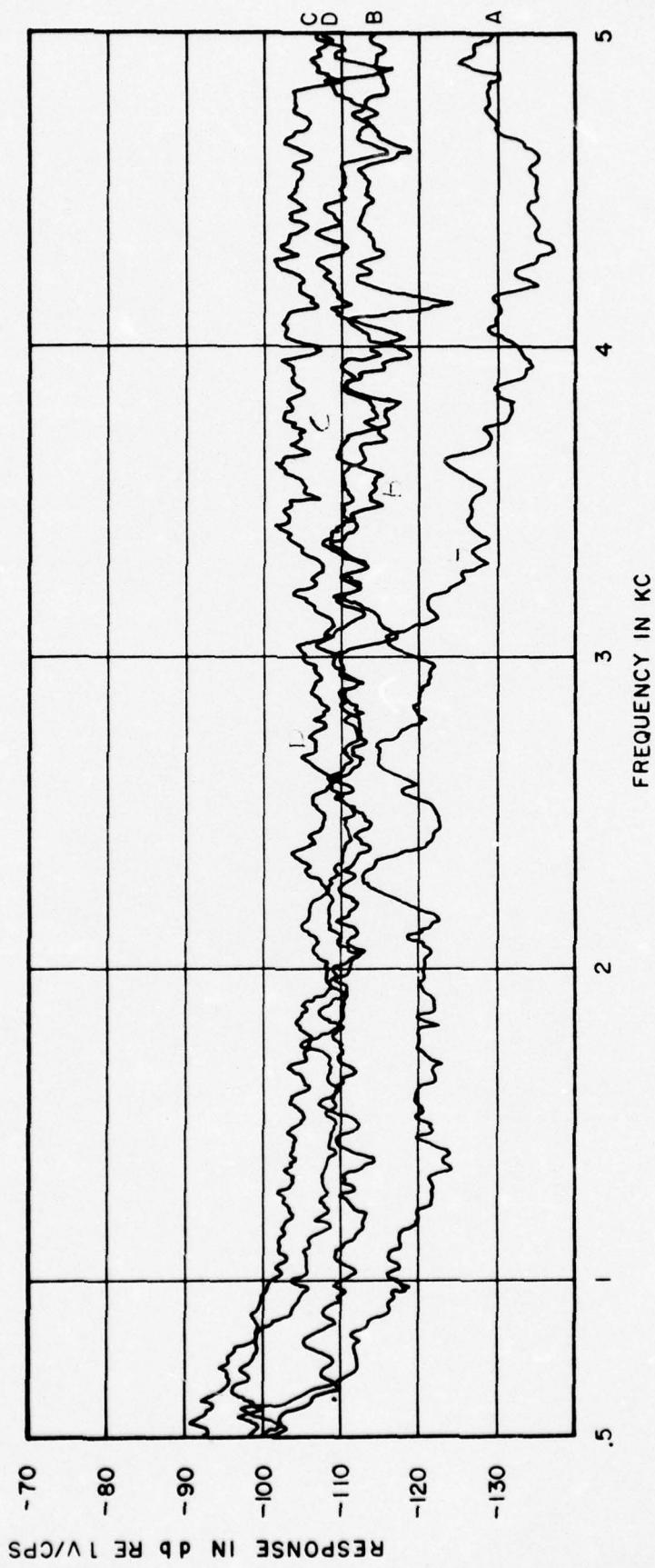


FIGURE 6-1 G1 NOISE SPECTRA: 5, 10, 15, 20 KNOTS

SEA CHEST NUMBER II  
ELEMENT NO. G3 (RECESSED)  
A 5 KNOTS, RUN 344  
B 10 KNOTS, RUN 345  
C 15 KNOTS, RUN 346  
D 20 KNOTS, RUN 347

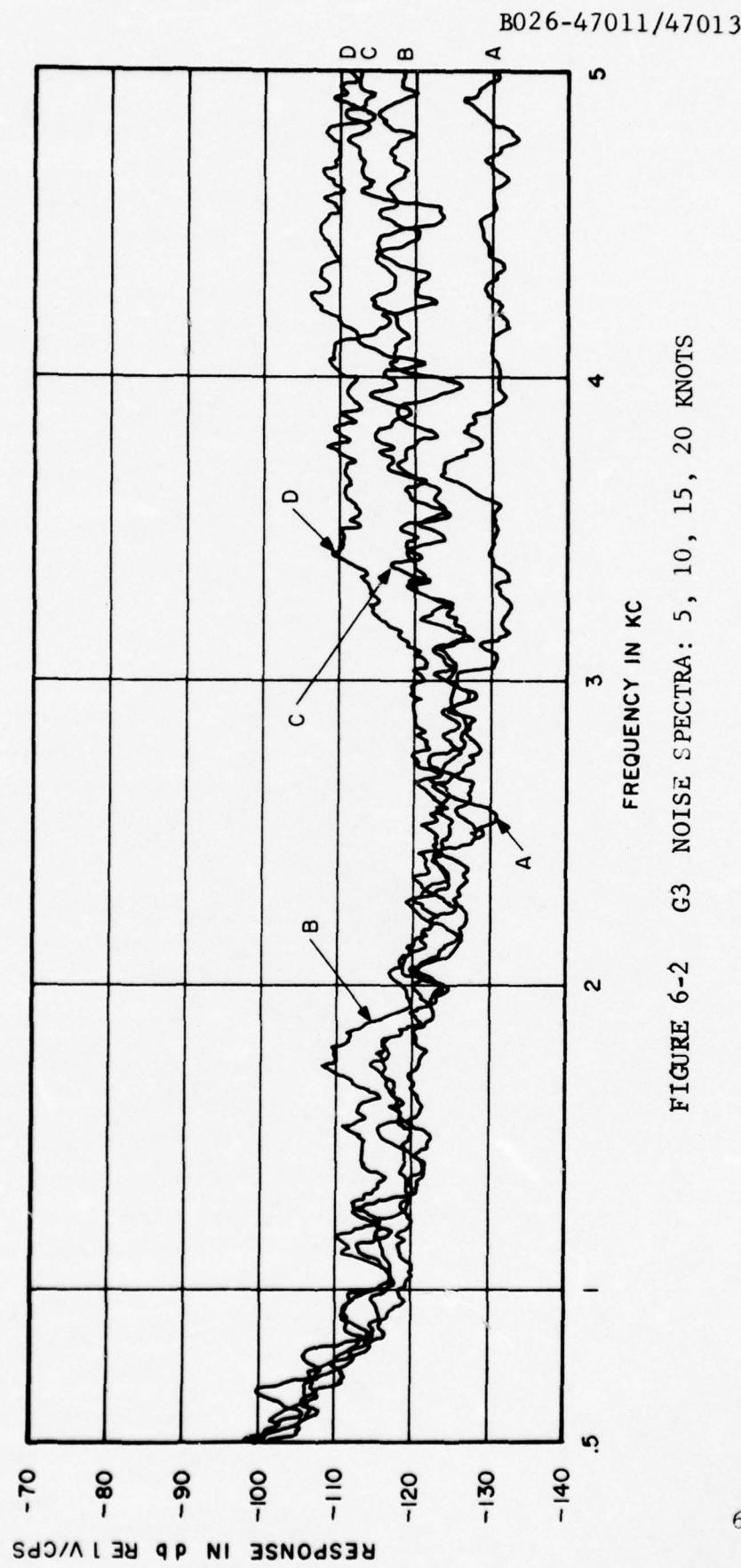


FIGURE 6-2 G3 NOISE SPECTRA: 5, 10, 15, 20 KNOTS

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SEA CHEST NUMBER II  
ELEMENT NO. G5 (RECESSED)  
A. 5 KNOTS, RUN 344  
B. 10 KNOTS, RUN 345  
C. 15 KNOTS, RUN 346  
D. 20 KNOTS, RUN 347

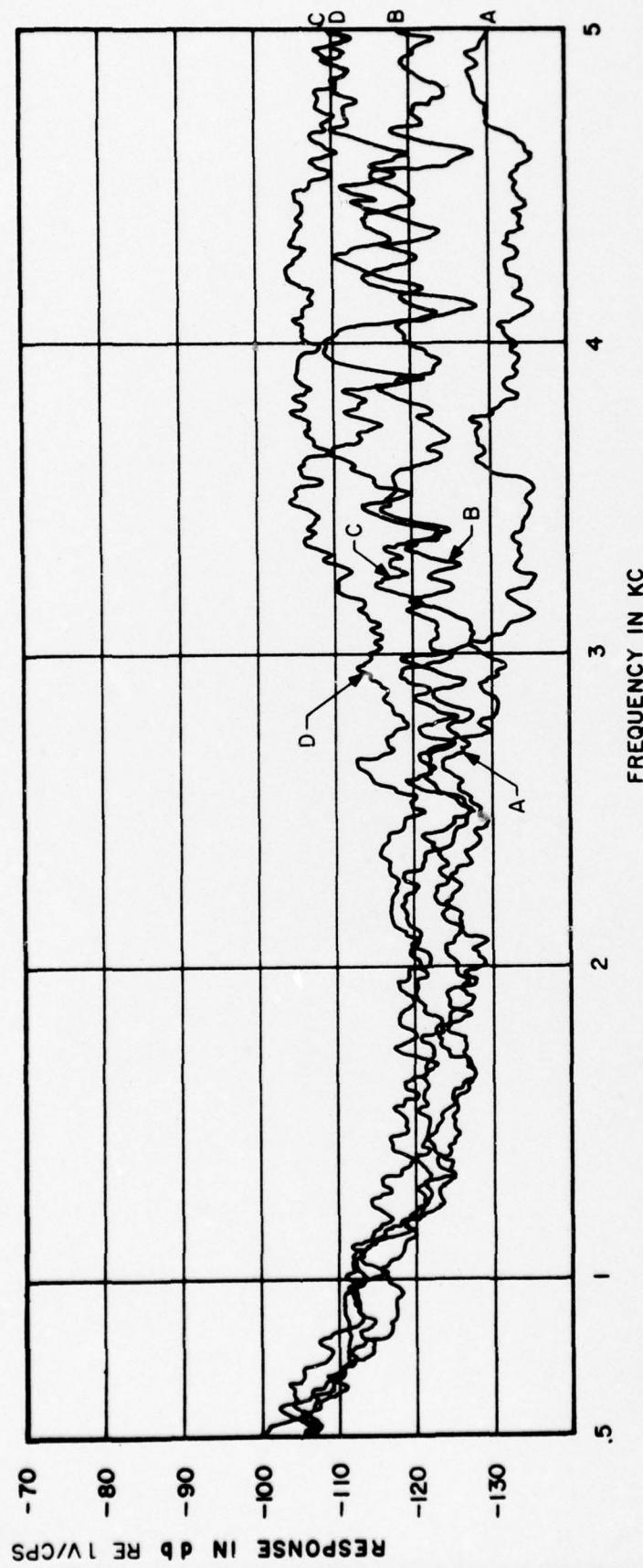


FIGURE 6-3 G5 NOISE SPECTRA: 5, 10, 15, 20 KNOTS

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SEA CHEST NUMBER II  
ELEMENT NO. G8 (FLUSH)  
A. 5 KNOTS, RUN 344  
B. 10 KNOTS, RUN 345  
C. 15 KNOTS, RUN 346  
D. 20 KNOTS, RUN 347

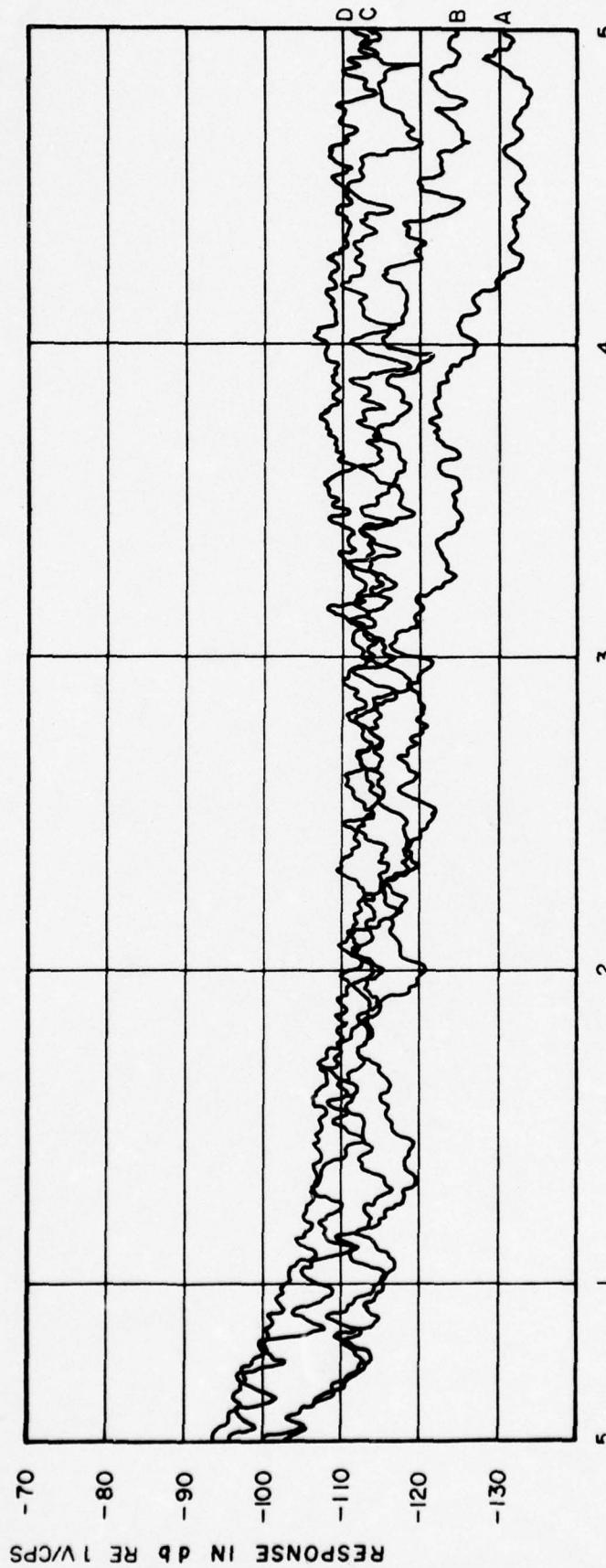


FIGURE 6-4 G8 NOISE SPECTRA: 5, 10, 15, 20 KNOTS

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SEA CHEST NUMBER II  
ELEMENT NO. G10 (FLUSH)  
A 5 KNOTS, RUN 344  
B 10 KNOTS, RUN 345  
C 15 KNOTS, RUN 346  
D 20 KNOTS, RUN 347

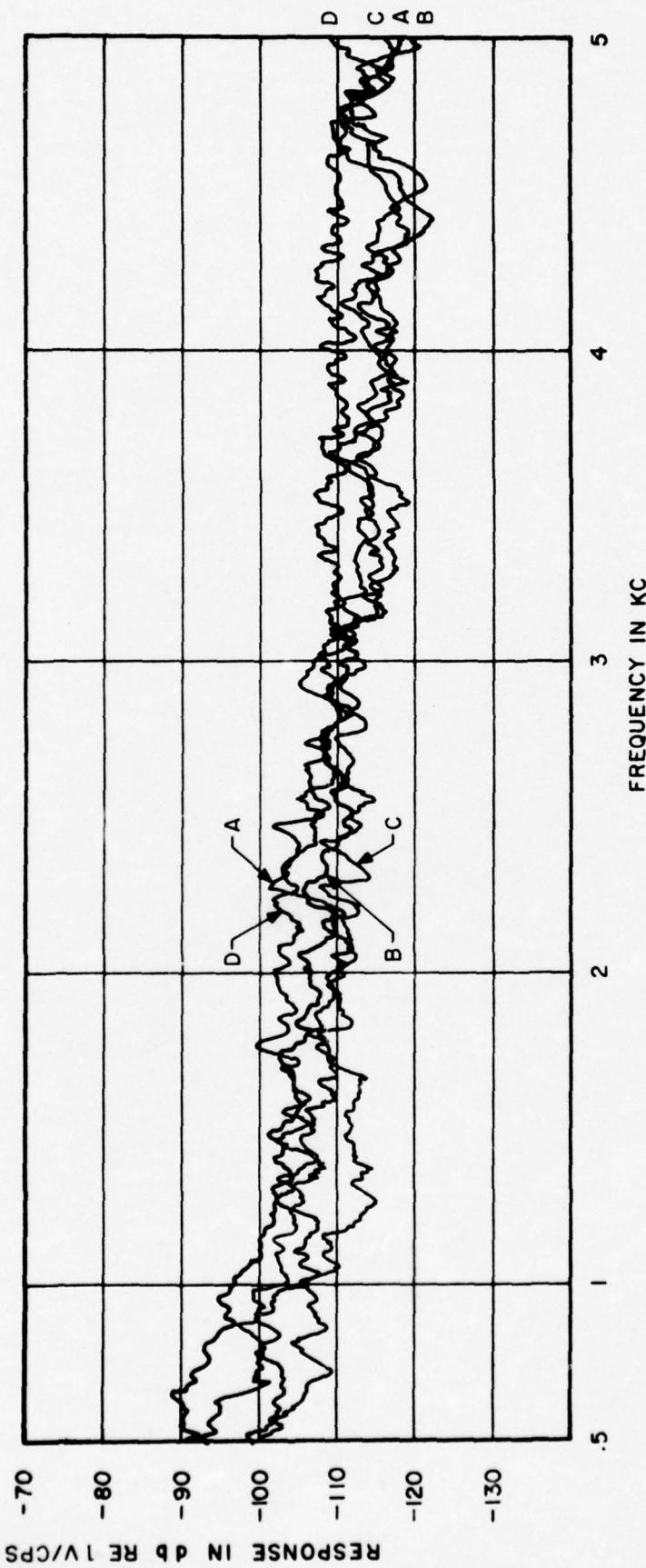
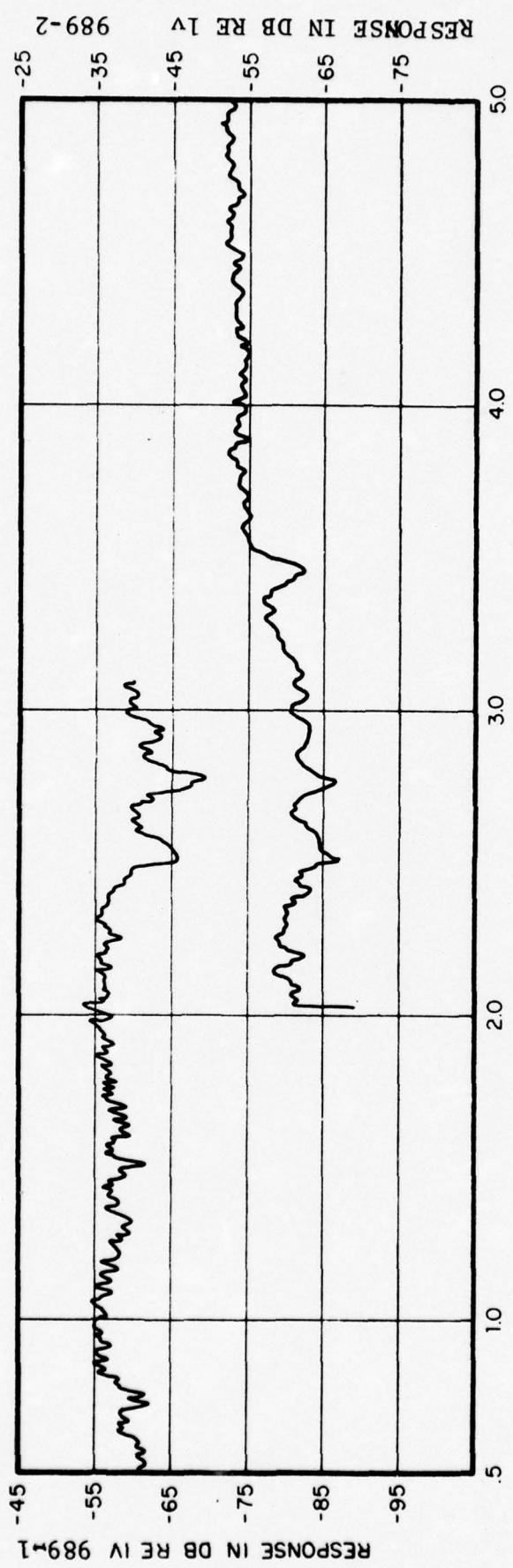


FIGURE 6-5 G10 (FLUSH) SPECTRA: 5, 10, 15, 20 KNOTS

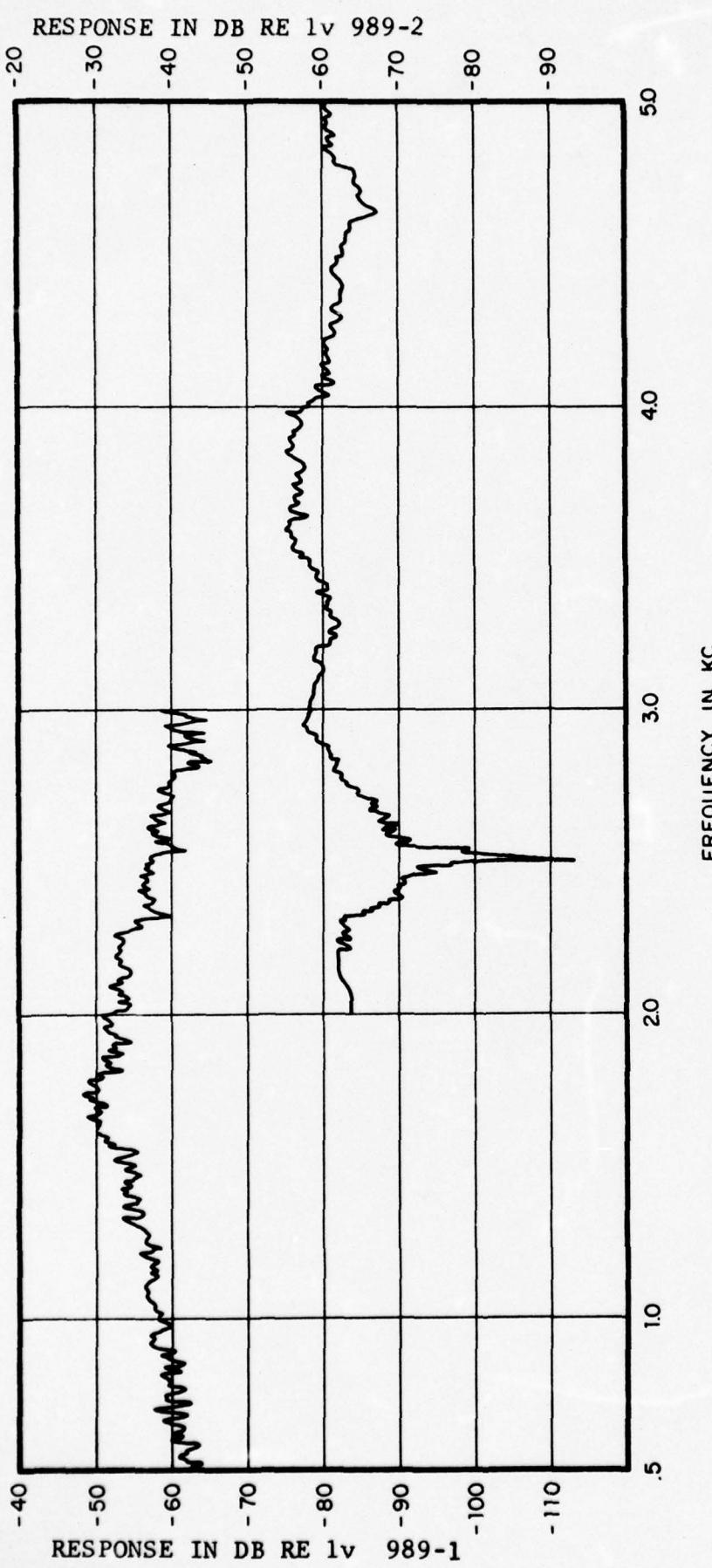
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OVERSIDE CALIBRATION RUN NO. 989-1,-2 ELEMENT G-5

FIGURE 6-6

6-1f

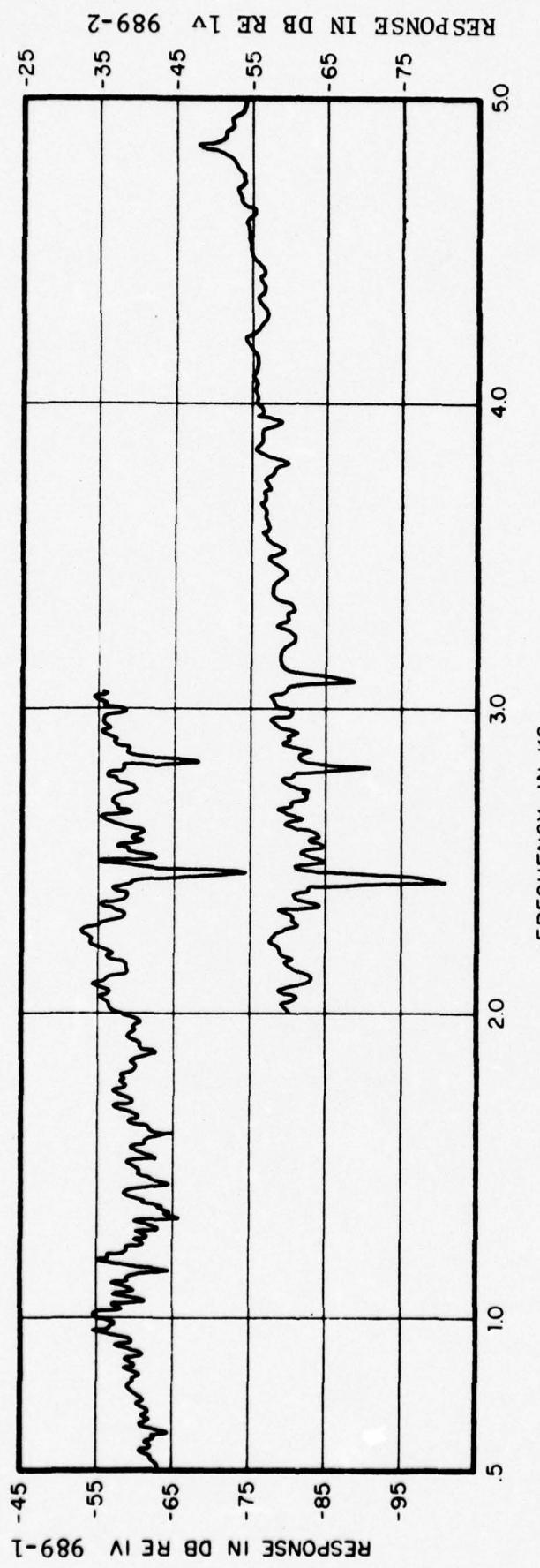


Overside Calibration Run No. 989-1,-2 Element G-8

FIGURE 6-7

6-1g

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Overside Calibration Run No. 989-1,-2 Element H-3

FIGURE 6-8

6-1h

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on ship speed ( $U_\infty$ ) is relatively weak up to 3 kc, specifically  $\lesssim 10$  db/speed octave for  $U_\infty \sim 10$  to 20 kt, corresponding to power dependence roughly as  $U_\infty^3$ . For the flush, hull-mounted element G10 this behavior continues on to 5 kc. In the case of the recessed elements, up to 3 kc the speed dependence is still weaker, except that there is a hump for G3 at 20 kt near 1.8 kc.

The levels for the recessed elements in this frequency interval at the higher speeds are for the most part lower than for the flush elements by  $\sim 10$  db, and their lack of speed dependence may correspond to the presence of a speed-independent noise component that is exceeded by the speed-dependent contribution for the flush elements but not for the recessed elements. Levels for the recessed elements are comparable with one another, except that the level for 5 kt is very low for G1. These comparisons of levels for different elements are significant only on assumption that free-field calibrations will indicate that the elements have similar sensitivities.

The frequency dependence of the noise for the flush elements from 0.5 to 2 kc at 20 kt is roughly -8db/octave, or as  $\omega^{-2.7}$ . This dependence refers to the raw noise measurements and will apply to the true noise spectra only if the free-field calibrations show that the element responses are nearly frequency-independent in the frequency range in question.

A disturbing feature of the overside calibrations of recessed and flush elements mounted in this sea chest is that repetition of a calibration run in some overlapping frequency range resulted in many cases in quite a different level both in magnitude and frequency dependence. No reliable conjecture as to the cause can yet be offered. No such discrepancies are observed in overside calibrations of hull-mounted elements. Also, in a given calibration run the spread among the levels for different recessed elements for the most part is greater than for flush elements in the sea chest.

The observed speed and frequency dependence may be

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compared with those for the 3"-diameter 5E elements of PURVIS 1, and the joint dependence compared with the theoretically conjectured scaling laws. The frequency dependence for 0.5 to 2 kc is generally similar to that for the 5E's, except somewhat weaker for 0.5 to 1 kc. (Results for the 5E's were somewhat erratic, however). The speed dependence for the flush elements (and still more for the recessed elements) is weaker for 0.5 to 3 kc than was observed for the 5E's. Likewise, the joint speed-frequency dependence disagrees with the conventional "outer" law for the spectrum  $Q_o(\omega)$  of turbulent boundary-layer (TBL) pressure fluctuations on a large element, namely

$$(1) \quad Q_o(\omega) = (\omega R_o / U_\infty)^{-2} \rho^2 \delta_*^3 U_\infty^3 N(\delta_*/R_o, \omega \delta_*/U_\infty),$$

where  $R_o$  denotes element radius and  $N$  is a function of the indicated dimensionless arguments\*. Specifically, from form (1), for  $Q_o(\omega) \propto \omega^{-2.7}$ , as observed we would infer\*\*

$$Q_o(\omega) \propto U_\infty^5.$$

An assessment of the effect of area dependence based on comparison with the 5E elements must await availability of free field calibrations.

We turn now to the frequency range 3 to 5 kc. The spectra for the flush elements tend to level off from 2 to 3 kc. Though levels for the lower speeds for the most part decline between 3 and 5 kc, those for the higher speeds remain roughly level or even rise somewhat. For the window-mounted flush G1 and G8, levels increase greatly from 5 to 15 or 20 kt in this

---

\* See Reference 4

\*\* The observed dependence disagrees still more with the "inner" law for a large element, namely

$$(\omega R_o / v_*)^{-3} \rho^2 v v_*^2 L_+ (\omega v / v_*^2).$$

The corresponding inner law for the TBL point pressure spectrum may be more nearly correct at high frequency than the conventional one.

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frequency interval, but the increase is erratic with the levels for different speeds even crossing at some frequencies. For the hull-mounted flush G10, on the other hand, the levels for 5 to 15 kt in this frequency interval are roughly independent of speed but higher than for the window elements at 5 kt.

It is recessed elements, however, that display the most conspicuous anomaly in the higher frequency interval. For speeds 10 kt and greater the levels broadly increase between 3 and 5 kc in a pronounced though erratic way. The overside calibration curves for the recessed elements on the other hand, though for the most part tending to rise somewhat between 3 and 4 kc, do not increase to such a degree as the noise levels between 3 and 5 kc. Likewise, so far as the gross behavior of the calibration curves in this range is concerned, the recessed elements are fairly similar to the flush ones. Pending further consideration, we advance no explanation for this anomalous apparent increase of noise with frequency.

## 2. Results for D elements (Figures 6-9 to 6-14)

The most striking feature of the results for the D elements is this: in no extensive frequency range do the noise levels for the elements beneath various thicknesses of layers have the inverse order of the thicknesses, even though in some ranges the differences in levels are substantial. Furthermore, the in-situ (overside) calibrations are very different for the various elements and likewise do not, in any appreciable frequency range, have the inverse (or direct) order of the corresponding thicknesses.

Since the measured noise spectra, even at the higher speeds, do not have the inverse order of the layer thicknesses, as would be expected if the elements have equal intrinsic sensitivities, we might conjecture that the in-situ calibrations differ not because of different total pressures on the elements in the calibration configuration, but because of some unintended alteration in the intrinsic sensitivity of some elements due to

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SEA CHEST NUMBER 1  
BOOT WIDTH = 4 59/64 - D4H  
A. 5 KNOTS, RUN 337  
B. 10 KNOTS, RUN 338  
C. 20 KNOTS, RUN 340  
D. 25 KNOTS, RUN 341

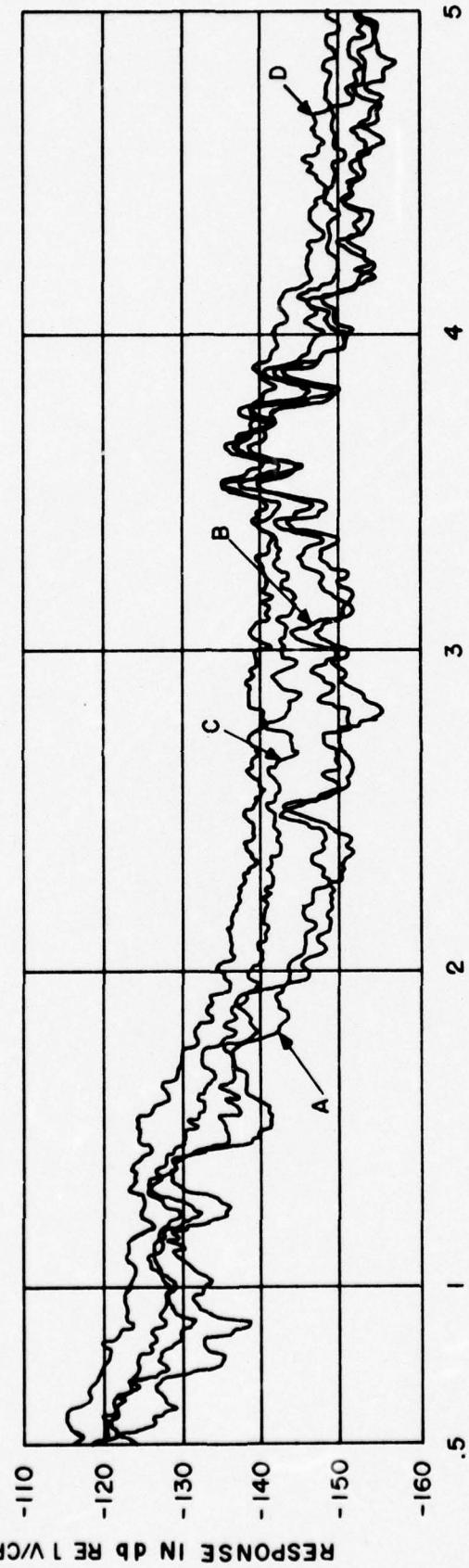


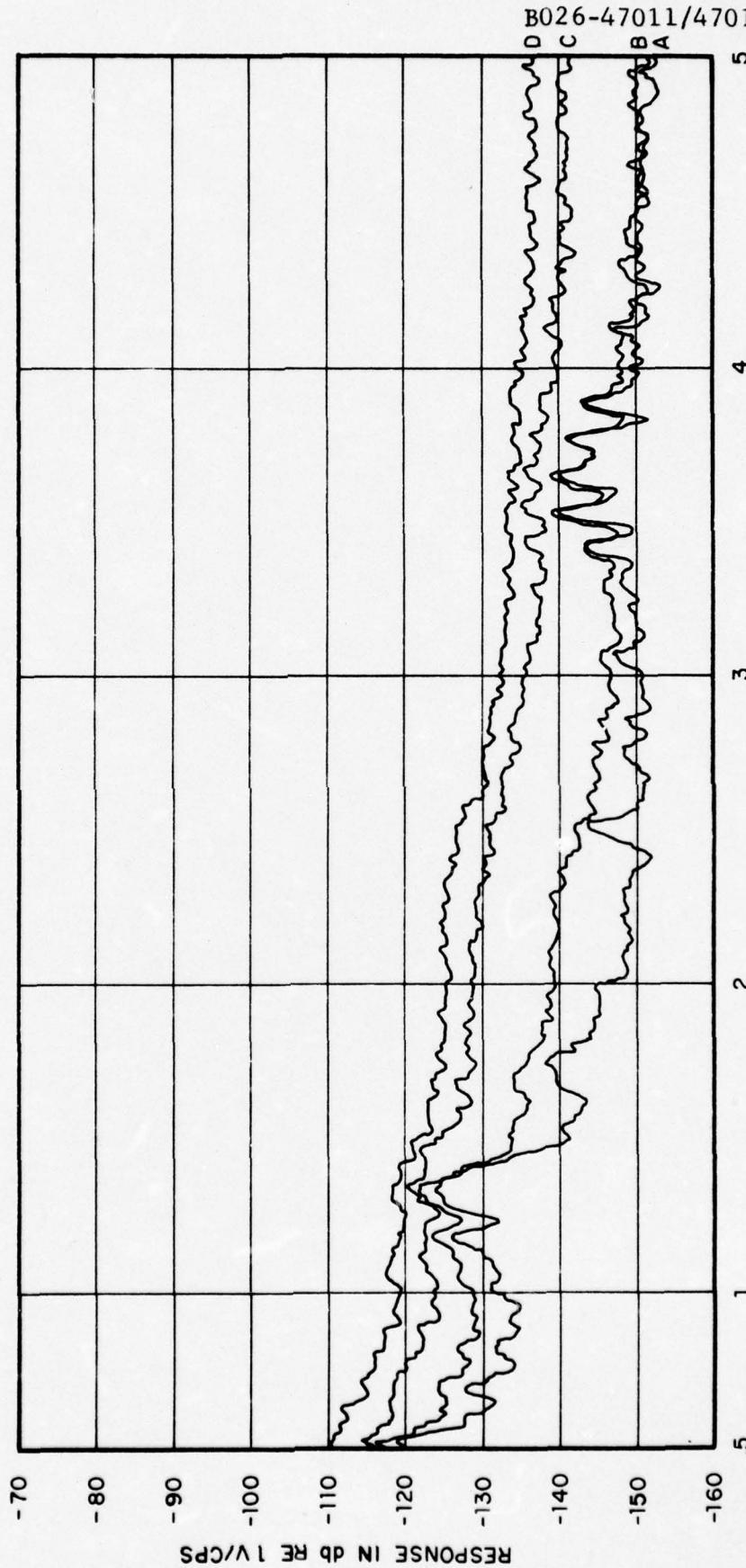
FIGURE 6-9 D<sub>4</sub> NOISE SPECTRA

6-4d

SEA CHEST NO. I

BOOT WIDTH = 5/8" - D5H

- A 5 KNOTS, RUN 337
- B 10 KNOTS, RUN 338
- C 20 KNOTS, RUN 340
- D 25 KNOTS, RUN 341



6-4b

FIGURE 6-10 D<sub>5</sub> NOISE SPECTRA

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SEA CHEST NUMBER 1  
BOOT WIDTH = 5 1/32" - D9H  
A. 5 KNOTS, RUN 337  
B. 10 KNOTS, RUN 338  
C. 20 KNOTS, RUN 340  
D. 25 KNOTS, RUN 341

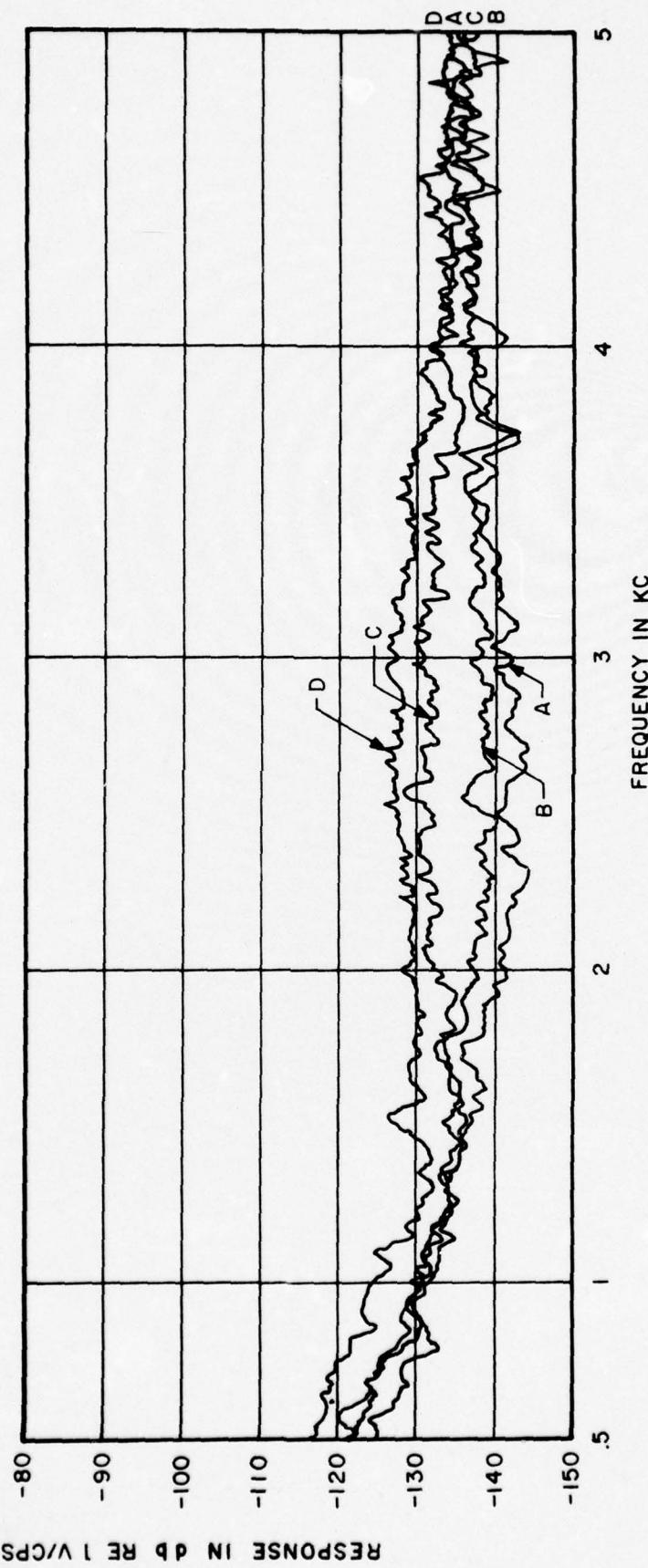
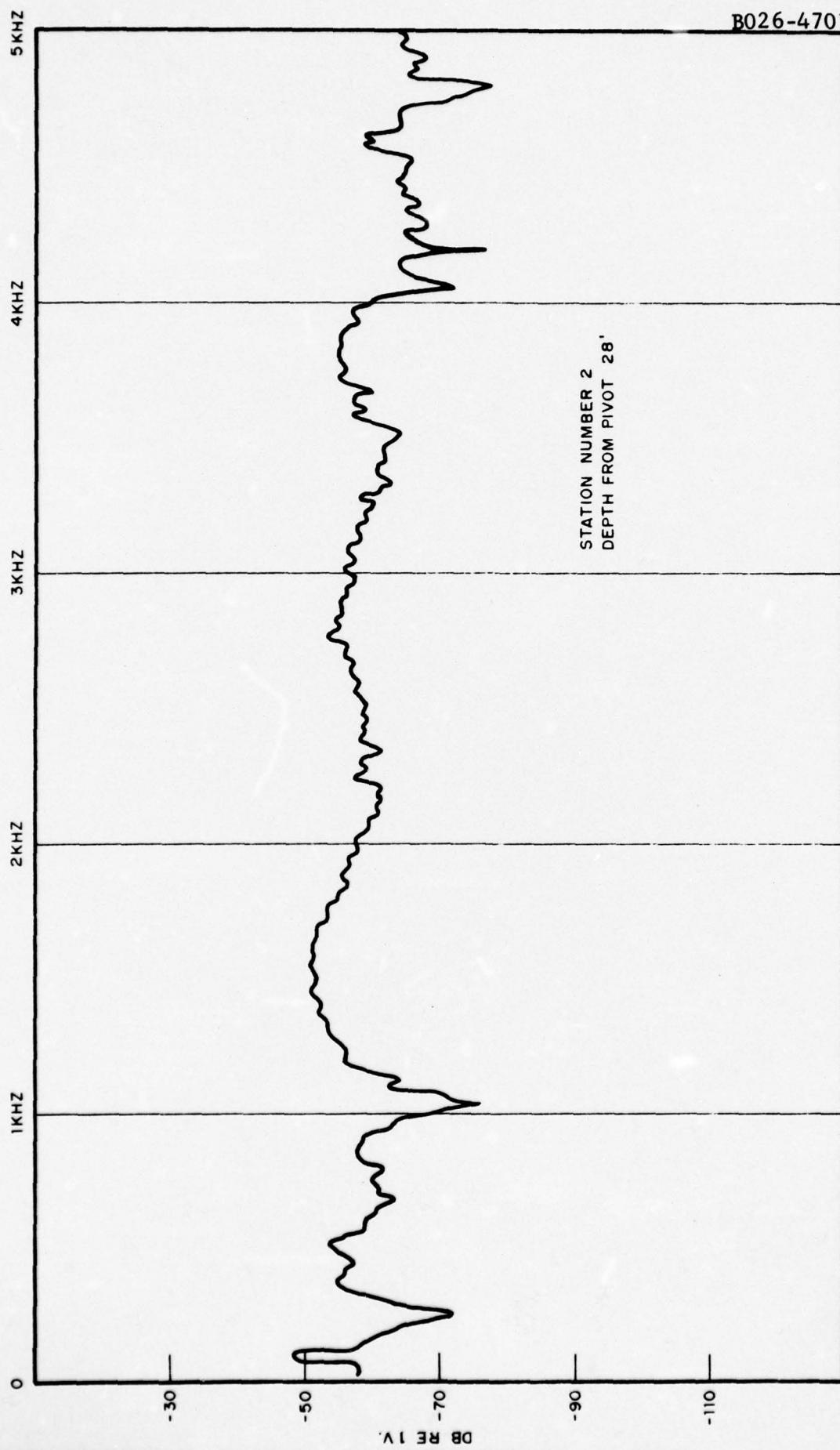


FIGURE 6-11 D9 NOISE SPECTRA

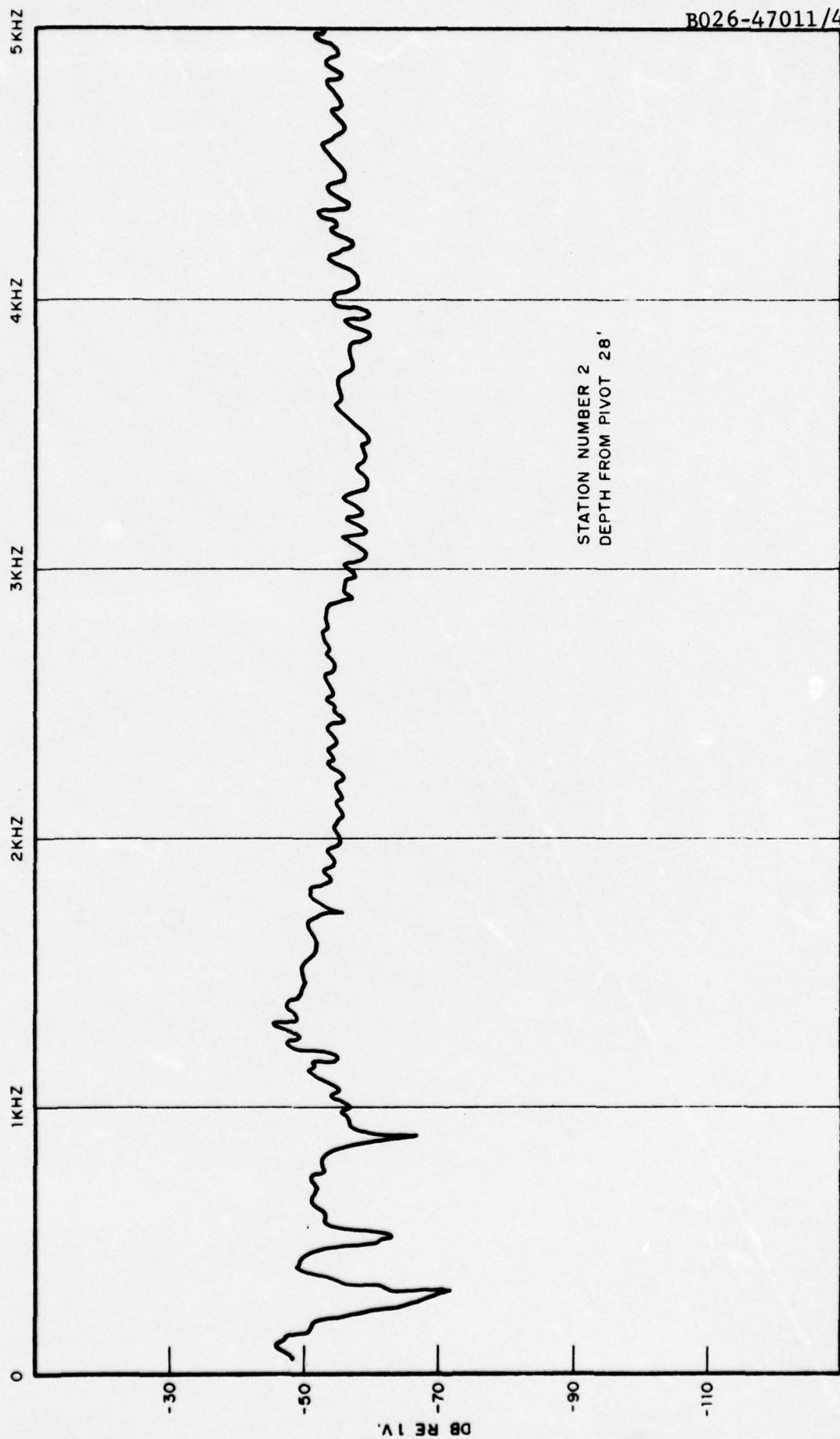
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6-4d

OVERSIDE CALIBRATION ELEMENT D4H  
RUN 983  
FIGURE 6-12

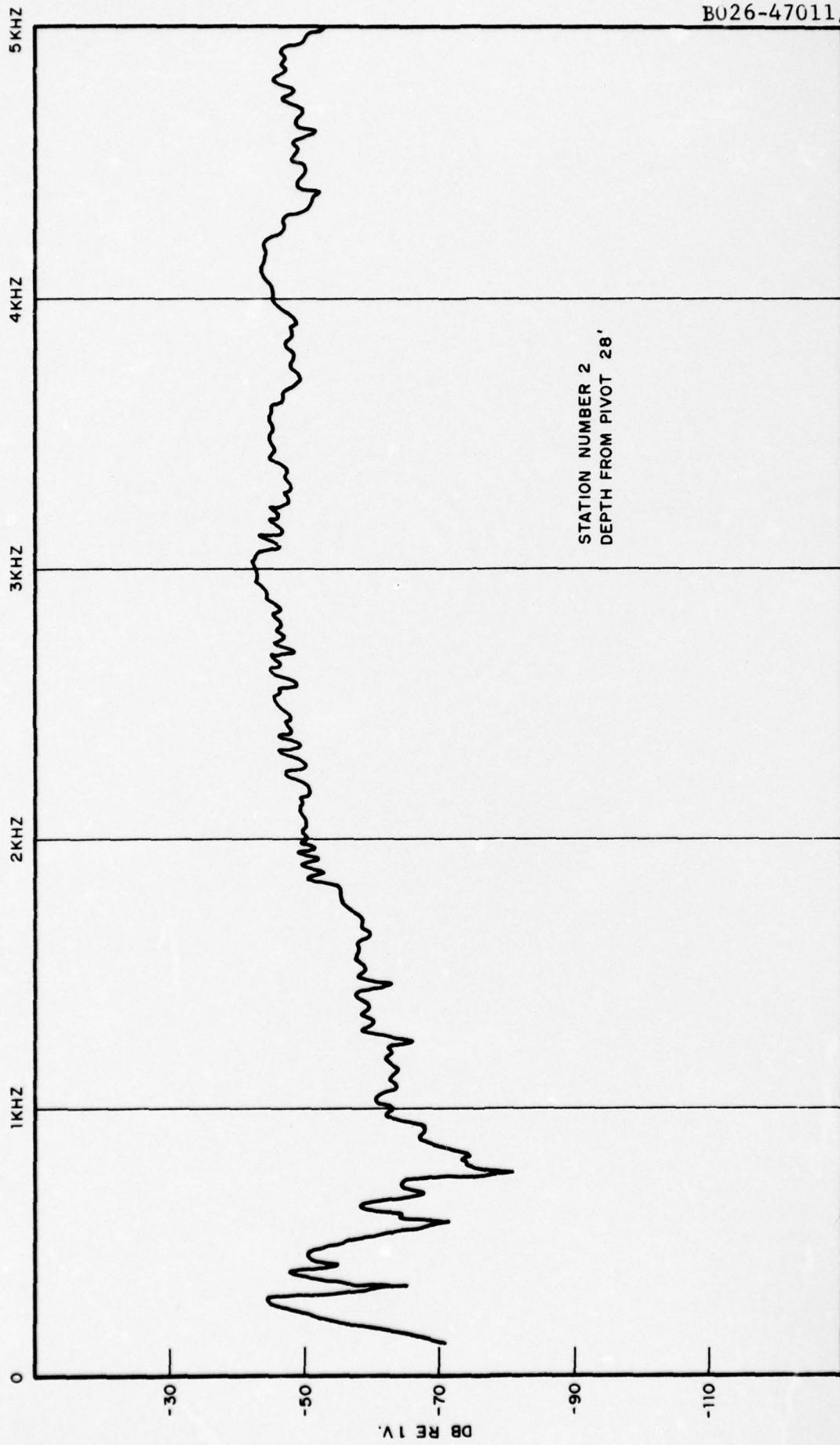
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6-4e

OVERSIDE CALIBRATION ELEMENT D5H  
RUN 983  
FIGURE 6-13

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OVERSIDE CALIBRATION ELEMENT D9H  
RUN 983

FIGURE 6-14

6-4 f

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peculiarities of their installation. A similar supposition is that trapped air was present under the layer over some elements, which would effect the response of the element to either a signal or noise applied on the outer face of the layer. Under such conditions, the desired absolute noise levels for properly mounted elements beneath the various layer thicknesses would be given more nearly by reducing observed noise levels by use of the in-situ sensitivities than by use of the intrinsic (or free-field) sensitivities of the unmounted elements. Unfortunately, however, application of this procedure yields reduced noise spectra that still do not have the inverse (or direct) order of thickness in any substantial frequency range.

Considerable doubt is cast on the validity of the in-situ calibrations, in any case, apart from their wide and erratic variations among elements, by the observation that the noise spectra at 5 kt, where the noise may be expected to be primarily acoustic in character, are much closer to one another, in general, than are the calibration curves. This fact suggests regarding the 5-kt spectra as effective relative calibration curves to use for the spectra at higher speeds. This procedure, however, also fails to yield a plausibly ordered set of spectra.

At very low frequencies, i.e., up to nearly 0.25 kc, however, for the higher speeds (20 and 25 kt) the order of the noise levels for the various elements (with the exception of D6 and D10 at 25 kt) is the expected inverse order of thicknesses. In this range, beginning from zero frequency the spectra are mostly rather flat for a short interval and then decline precipitately up to about 0.4 kc, by which point the level order is mixed; the rate of decline with frequency then becomes smaller on the order of that observed at such frequencies with flush elements. We are unable to propose a positive reason why the regular order of levels observed at very low frequencies should not persist to much higher frequencies.

A theoretical account of the possible acoustic noise reduction by a covering layer is given in summary in Appendix G.

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We also supply here a brief theoretical orientation. The noise spectrum is regarded as the sum of three parts: (a) high-wave number (eddy-convection) noise due to the TBL; (b) low-wave number noise due to the TBL (c) noise due to a radiated sound field (including any associated with the TBL). Component (b) (with suitable adjustments in (a) and (c)) may be roughly assumed to be wave-number white.

In the present tests, even the thinnest layer ( $5/8"$ ) is expected to be sufficient to eliminate the high-wave number component (a). All of the layers, on the other hand, are expected to leave the radiative component (c) nearly unaffected. Finally, the layers will reduce wave number-white noise as a function of thickness L and frequency according to a formula given in Appendix A. Thus only component (b) of the noise is expected to depend on L over the range of L embraced by the tests. Hence, if the L-dependence is substantial at very low frequency, as observed, it will remain substantial up to frequencies where either (1) the wave length ( $\lambda = 2\pi c/\omega$ ) of sound in the water or layer is only  $\lesssim 3/2$  times the element diameter or  $\lesssim 9$  times the layer thickness, so that component (b) becomes L independent, or (2) the entire component (b) has become rather smaller than component (c) on account of a more rapid decrease with frequency. If the L-dependence observed at low frequency in the tests is real, its obliteration above  $\sim 0.25$  kc would not be due to the former condition and could be attributed only to the latter. The pronounced but erratically variable dependence on thickness at higher frequencies, however, remains totally unaccounted for.

We are thus unable to make much sense of the results. If some credible criterion could be discerned for accepting the data for some elements as meaningful and those for others as not, then some apparently sensible account might be given. Since there is no clear criterion to use, however, the likelihood of selecting data to suit one's prejudice is obvious.

We shall now discuss further the observations for elements D4, D5, and D9, for which the noise levels at multiple

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speeds are shown in Figures 6-9 through 6-11. That part of the discussion which concerns the reduction of noise relative to a flush element or the reduction by the thicker layer relative to the thinner is given by way of example, but the conclusions are not to be credited, since, in accord with the remarks above, the selection of other elements would lead to conclusions different from and inconsistent with these. Similarly, the discussion based on in-situ calibration curves is not to be accepted.

The noise spectra for D5 and D4 clearly indicate some speed-independent component in fairly narrow bands centered at about 1.3 and 3.7 kc. Assuming, as we shall, an intrinsic element sensitivity of -108 db re 1 v/ $\mu$ bar, the maximum levels of these components appear to be about -19 db and -32 db re 1 ( $\mu$ bar)<sup>2</sup>/cps. respectively. In the case of element D9 the component at 1.3 kc appears to be absent, and that at 3.7 kc also does not appear, though it could be masked by the higher noise level seemingly prevailing there for this element.

We discuss results for the element D5 with the thinner boot. The speed dependence weakens as the frequency decreases toward 0.5 kc; in fact, there is a suggestion of another speed-independent component with peak near 0.5 kc. Concerning speed dependence in the ranges apparently least affected by speed-independent components, at  $\sim$ 0.8 kc for 10 to 20 kt the speed dependence is roughly as  $U_{\infty}^2$  (6 dt/speed octave) and for 10 to 20 kt as  $U_{\infty}^{2.6}$ ; at  $\sim$ 2 kc for 10 to 20 kt the dependence is as  $U_{\infty}^{3.6}$  and for 10 to 25 kt as  $U_{\infty}^4$ . As for the frequency dependence, at 25 kt we have the result:

Frequency interval (kc)	0.5 to 1	1 to 2	2 to 4
Db decrease	9	7	9

The average dependence over 0.5 to 4 kc is thus as  $\omega^{-2.7}$ , just as found (at 20 kt) for the flush G elements. Hence, again the speed dependence is too weak to correspond to scaling form (1) (which, in the regime in question, remains roughly

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correct for a shielded element if correct for a flush element, so far as the speed and frequency dependence are concerned).

Regarding absolute noise levels, using the assumed sensitivity, we obtain the levels recorded for 20 kt in the following table along with comparative levels at 20 kt obtained for typical elements in the PURVIS I tests and for an element at similar distance aft in G. Franz's measurements on the submarine Albacore.

TABLE 6-1. Noise levels in db re 1 ( $\mu\text{bar}$ )<sup>2</sup>/cps for various elements at 20 kt.

<u>Test, element</u>	Element diam. (in.)	Frequency (kc)			
		0.5	1	2	4
Albacore, 46 ft aft	0.11	36	33	18	
PURVIS I, 1638	0.125	29	22	7	-13
PURVIS I, 5E61	3	-14	-25	-30	-37
PURVIS I, 5E111	3	0	-12	-18	-27
PURVIS II, D5	1.5	-7	-15	-21	-32
PURVIS II, D4	1.5	-12	-20	-31	-39
PURVIS II, D9	1.5	-14	-22 (-25)	(-25)	

It is unfortunate that there is no flush element of the same size and type as the D elements with which comparisons of noise levels on the layer-covered elements can be made. As it is, comparison can best be made with the 5E's of PURVIS I. The 5E which was at the source station aft was 5E61. That element, however, measured noise levels 12 db or more below those measured by the other 5E's, all of which were stationed further aft in or near Sea Chest 2 (for example, see noise for element 5E111 in Table 6-1). This difference obtained despite the fact that element 5E111 was situated about 9 feet below the lower edge of Sea Chest 2 and hence far removed from the water surface. If, nevertheless,

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we credit the measurement of 5E61, we note that the noise level for D5 with the 5/8" covering layer was 5 to 10 db higher; this difference might be attributed to the greater area of the 5E element, but in any case suggests no substantial noise reduction by the layer on D5. If, on the other hand, we discredit 5E61 and suppose that such an element at that location should measure noise no lower than that measured by 5E111 further aft, we note that the noise level for D5 was 3 to 7 db lower than that for 5E111, despite the larger area of the latter, thus suggesting substantial noise reduction by the layer.

We recall the contingent theoretical expectation with regard to the effect of the 5/8" layer on the noise relative to a flush element of the same (1.5") diameter: (a) high-wave number (eddy-convention) TBL noise should be virtually eliminated; (b) wavenumber-white TBL noise should be reduced by 7.4 db; (c) noise due to a radiated sound field should be left nearly unaffected.

We proceed to consider the results for elements D4 and D9 with the thicker layers (actually conically expanded boots). Though the layer thicknesses for D4 and D9 are nearly equal, and the noise levels are likewise nearly the same up to  $\sim$ 2 kc, the levels for D9 become much higher than for D4 at higher frequency. Comparing in-situ (overside) calibrations, we see that the calibrations for D4 and D9 are similar in form and rough magnitude up to 1.7 kc, but that the indicated sensitivity of D9 then rises, while that of D4 falls, so that whereas the average sensitivity for D9 from 2 to 4 kc is  $\sim$ -46 db, that for D4 is  $\sim$ -58 db. The calibration curve for D5, on the other hand, is similar to that for D4 on up to  $\sim$ 4 kc. We are led to think that the in-situ sensitivities for D4 and D9 differ in the higher frequency range not because the effective pressures in calibration in-situ differ, but because some differences in installation have caused the effective intrinsic sensitivities of the two elements in this frequency range to differ, thus affecting also the sensitivity to noise pressure. On this assumption as stated earlier, even though it is a comparison of absolute noise levels that is

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desired, the respective noise levels measured by the elements in this range should be altered to reflect the in-situ calibration difference. The levels so corrected no longer display the anomalous difference noted.

Comparing results for D4 and D5 at 20 kt, we see that the thicker layer has apparently reduced the noise level relative to the thinner by ~5 to 10 db. Correspondingly, the levels for D4 are lower than those for 5E111 of PURVIS I by 8 to 13 db; they are roughly the same as those for 5E61 of PURVIS I.

Returning to theoretical expectations, the effect of the thicker boot on the high-wavenumber noise is irrelevant (since this is negligible even with the thinner boot) and on the radiation noise is still minor. On the other hand, up to about 1 kc the wavenumber-white noise should be reduced by 18 db relative to the thinner boot, and by a decreasing amount at higher frequency.\* This estimate applies to a laterally large planar layer, however, and the reduction would be expected to be somewhat smaller for a conical boot of the type employed. No trend toward convergence of the spectra with increasing frequency is discernible from the measurements.

#### B. TRANSMISSION TESTS (Figures 6-15 to 6-18)

Analysis of data from transmission tests to date have been limited to analog records of the envelope of received signals after narrow band filtering. Two different techniques were employed for this purpose.

Figure 6-15 is an oscillographic record of the filtered signals from several hydrophones during a transmission test. This particular record was selected from a longer record made during real time on board the PURVIS, at a point when the received signal at one of the flush-mounted hydrophones was significantly affected by bubble clouds passing between the transmitter and the receiver. Ship's speed was 20 knots.

\*The results quoted here for wavenumber-white noise are based on the formula given in Appendix G.

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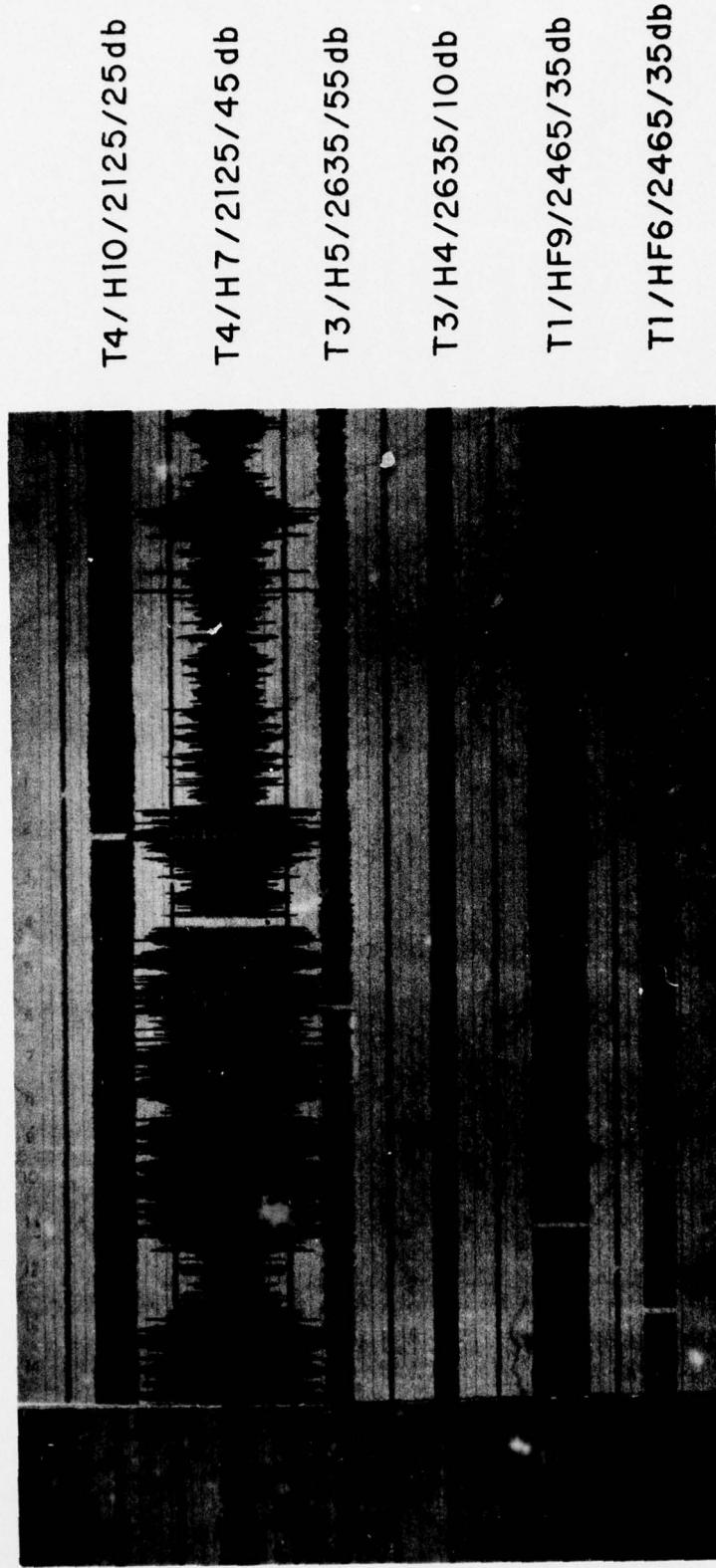
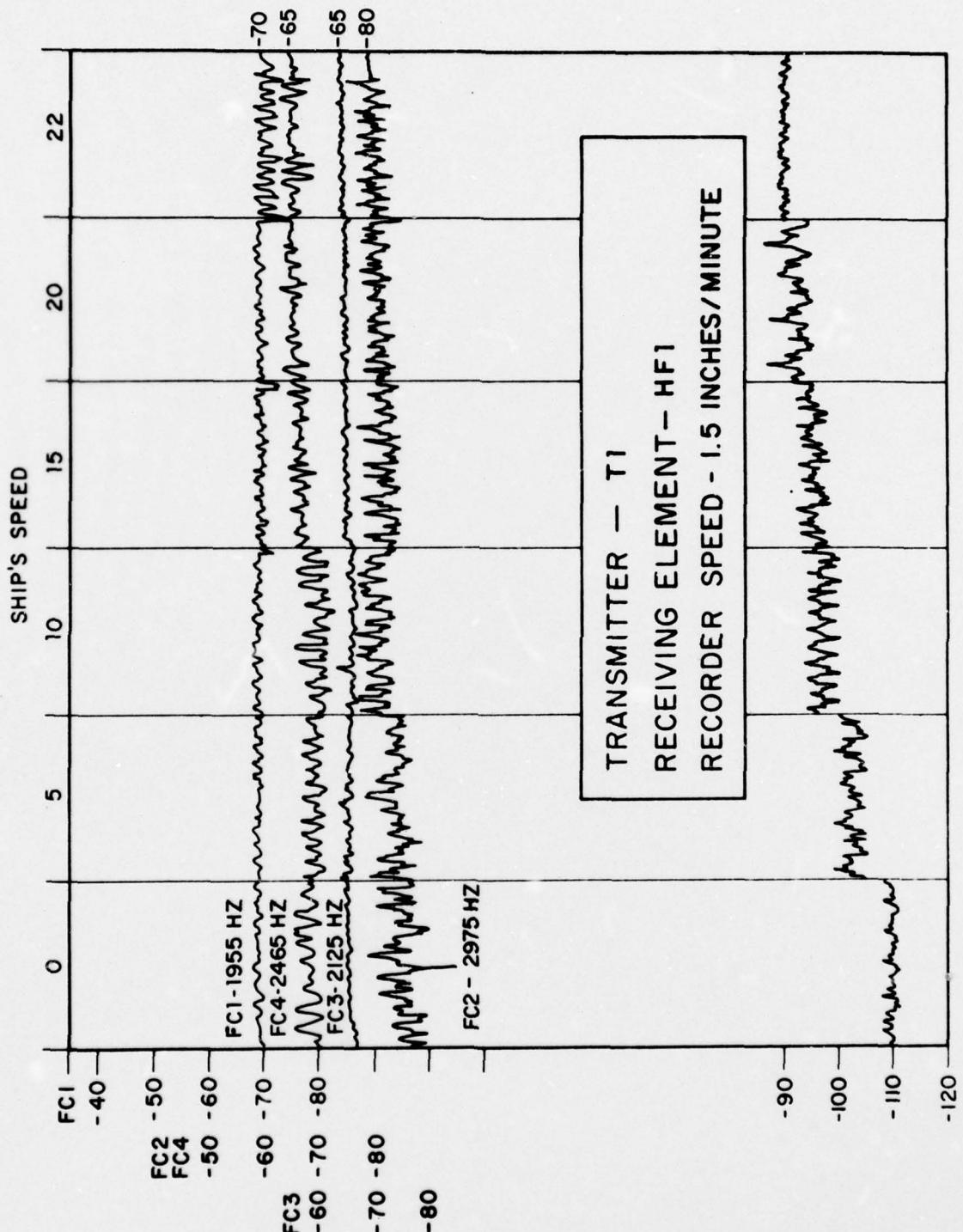


FIGURE 6-15 OSCILLOGRAPH OF HULL RECEIVERS DURING TRANSMISSION

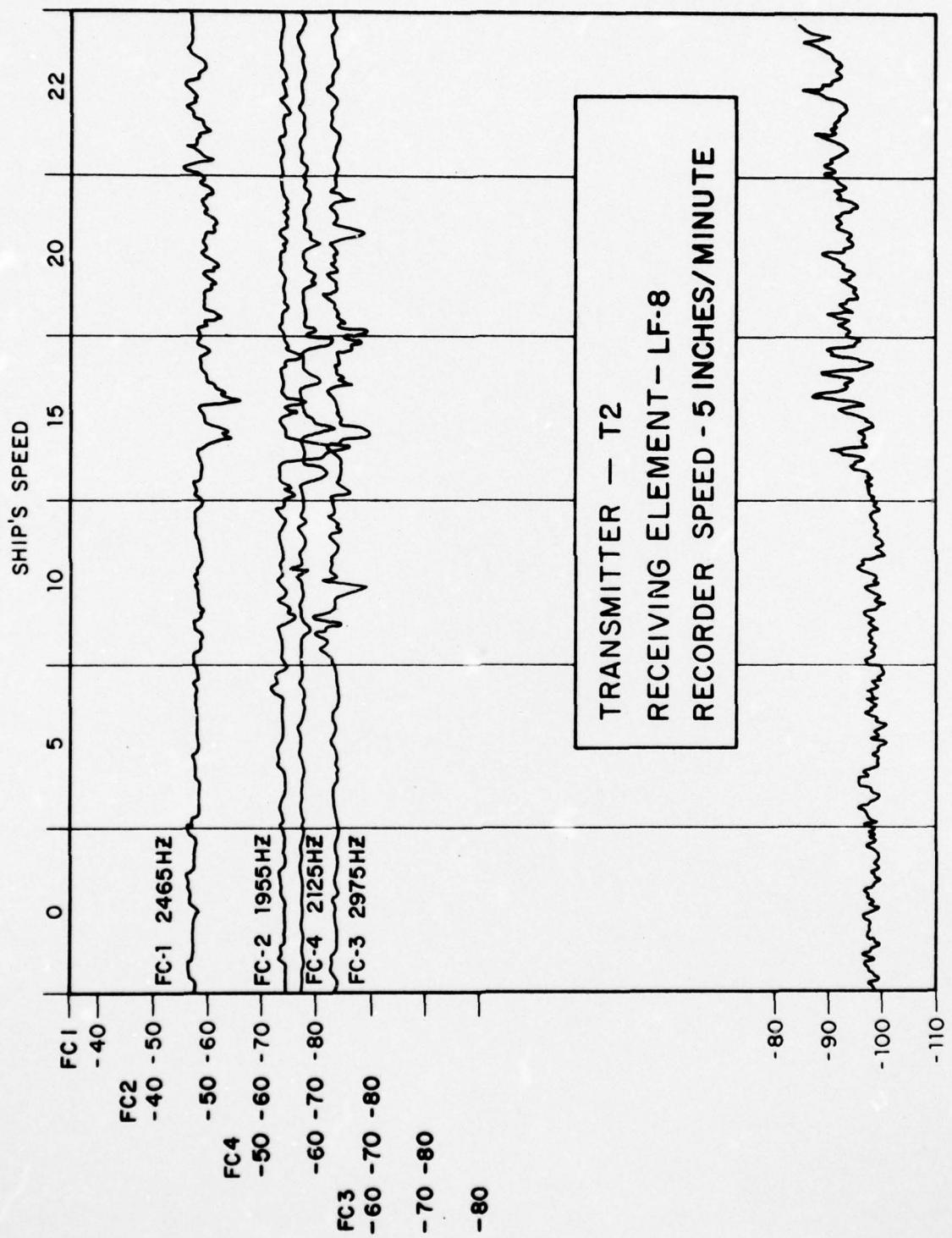
B026-47011/47013



PASSIVE RECEPTION AT 2465 Hz

FIGURE 6-16

B026-47011/47013



6-10c

TYPICAL PASSIVE RECORDING - 2465HZ

FIGURE 6-17

B026-47011/47013

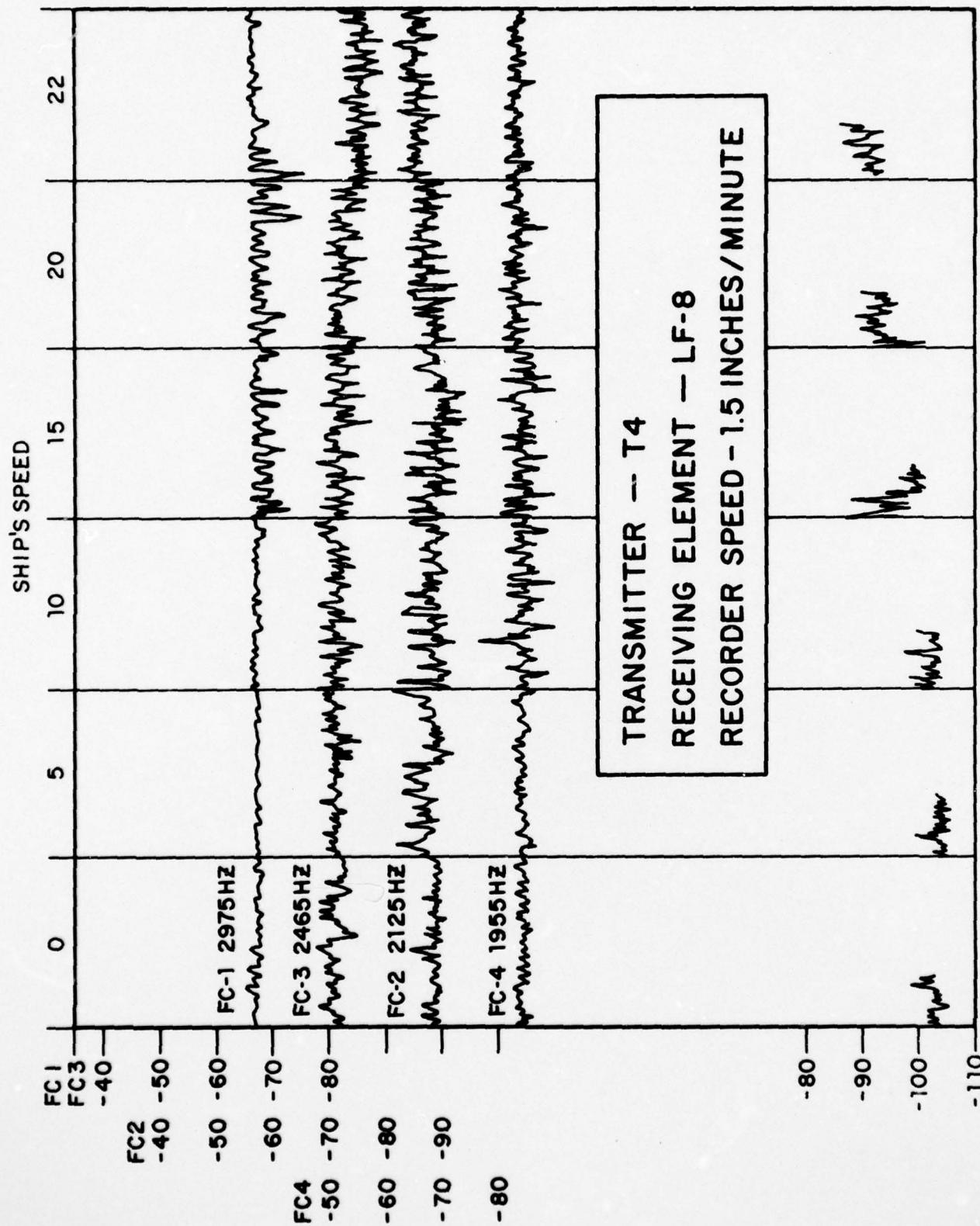


FIGURE 6-18 TYPICAL PASSIVE RECORDING - 2465 Hz

**CONFIDENTIAL**

The traces at the extreme left side of the record represents the ambient noise levels prior to transmission appearing at each hydrophone in a 80 Hz band centered at one of the three transmission frequencies subsequently used. The balance of the record was made during the transmission period. The amplitude variations observed at receiver H-7 were quite discernible. In this short time history record (i.e., approximately 5 seconds) some of the amplitude depressions are between 15 and 20 db down from the nominal amplitude. The same transmitted signal received at H-10, however, shows practically no amplitude variations during the same time interval. This condition is, as expected, since receiver H-7 is located approximately 2 feet above the keel and 10 feet off the ship's center line, whereas receiver H-10 is located a few inches above the keel and 1 foot off the ship's center line. (Note: the "db" values for each of the six traces refer to amplification added after the narrow band pass filters of the Combiner-Separator panel.)

A second method of obtaining analog records of the transmission tests utilized the General Radio wave analyser and level recorder. For this application the GR center frequency was set to one of the transmission frequencies with a bandwidth of 50 Hz, and a time history of a receiver signal was recorded as a logarithmic amplitude record. Figures 6-16, 6-17 and 6-18 are composite records of the received signal at one hydrophone from one transmitter, at various ship's speed and transmitting frequencies. The passive noise levels at 2465 Hz for each speed are also illustrated. The passive noise levels indicate that at receiver LF-8 the amplitude at 2465 Hz was essentially constant until the ship's speed was 15 knots or greater. At 15 knots large amplitude modulations were exhibited in the received signal level at LF-3 for all four frequencies, from both transmitters T2 and T4, due to bubble clouds, ship's motion, etc. The sea state during these runs was "2".

**CONFIDENTIAL**

**CONFIDENTIAL****C. ACTIVE TRANSMISSION**

For active transmission runs we are interested in the normalized mean and variance of the envelope or average power of the received signal for finite time intervals. The normalization is with respect to zero speed or flow to indicate absolute levels of attenuation. We are also concerned with the mean and the variance of the phase difference between the transmitted and received signals normalized with respect to phase difference at zero speed.

The finite time intervals of interest correspond to the inverse bandwidths of anticipated active sonar input filters (long or short CW pulses), and the mean and variance as a function of consecutive time intervals are of interest to correspond to the motions or flow of bubble clouds.

Although special programs could be prepared to analyse these items, the timing and funding may preclude any such effort at this time. As an alternative, we are preparing oscillograph runs of received signals to show instantaneous output signals and variations in the envelope when passed through appropriate band pass filters. The cross-correlation between the transmitted and received signals will yield a function which is dependent on both amplitude and phase variations. Band limiting (clipping) of the signals prior to cross-correlation will give only phase dependent results.

**CONFIDENTIAL**

## SECTION VII

PLANS FOR FINAL DATA REDUCTION

## A. GENERAL

A joint TRG-DTMB meeting was held at the Model Basin on September 7, 1966 for the purpose of reviewing the status of acoustic data processing and analysis for both PURVIS I and II. During the meeting, TRG presented an analysis plan for the PURVIS II data (see end of section) which would satisfy the prime test objectives of the PURVIS II Sea Trials. This plan was basically accepted, supplemented by some additional requirements put forth by DTMB for both PURVIS I and II.

Subsequent to the meeting, funding for data processing and analysis was significantly reduced for the balance of Fiscal 1967. In view of this, the comprehensive processing and analysis planned for both PURVIS I and II acoustic data had to be judiciously "pruned". In addition, the implementation of new computer programs for new applications (i.e., transmission attenuation) or more efficient computer usage (i.e., Cooley-Tukey high speed spectrum analysis), was essentially terminated.

## B. PROGRAMMING EFFORTS

One general agreement between TRG-DTMB was that all noise spectra data being plotted in the dimensional form of power (db re 1 microbar<sup>2</sup>-sec) vs. frequency in Hz should be plotted on one continuous plot rather than in 3 linear frequency bands, as is presently being performed for PURVIS I data.

Note: the 3 frequency bands used were 100 Hz to 1000 Hz, 1000 Hz to 3000 Hz and 3000 Hz to 10000 Hz. Formatting and digital computations were performed 3 times for the same analog data by using analog filters prior to formatting). Programming efforts have been initiated to modify the present output plotting tape to include this capability as well as a "non-dimensional" form with a log frequency abscissa. Additional programming

efforts may be required for processing transmission attenuation data, after an analysis of the results from the data reduction order described below has been completed.

#### C. ACOUSTIC CALIBRATIONS

Another general agreement at the joint meeting was that free-field calibrations should be used for the presentation of all noise spectra (PURVIS I and PURVIS II). The processing operation at NEL Data Conversion Center (See Appendix E) presently provides for the inclusion of correction data, such as tape skew correction, hydrophone acoustic sensitivity, etc., on the header record preceding the digitized and formatted analog data on the formatted digital tape. The analysis program, which performs the computations for auto-and cross-correlation, and cross and noise spectra, utilizes both the header record and the formatted data.

The TRG 5-inch elements had not been calibrated prior to installation in the ship and acoustic calibrations are presently being performed at the U.S. Navy Underwater Sound Reference Laboratory (USNUSRL), Orlando, Fla., under the cognizance of DTMB.

However, these tests for frequency response are just starting, and TRG has not been furnished with any test results to date. Hence, TRG plans to defer formatting and analysis of acoustic data requiring frequency response corrections until the latter information has been received.

#### D. PURVIS II DATA REDUCTION ORDER

An initial data reduction order has been submitted to the Data Conversion Center at NEL (see end of section), and to DTMB. The acoustic data processing requirements within this order include auto and cross correlations, power and cross

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spectrums, amplitude distributions and some analog recording of received signals during transmission runs. Accelerometer data associated with both the TRG 5" receivers and the DTMB FS-13 receivers will be processed using the General Radio Wave Analyzer.

As a result of recent processing tests the specifications for formatting have been modified for improved efficiency above the PURVIS I procedures. Instead of using three frequency bands between 100 Hz and 10 KHz, two processing bands (200 Hz to 2 KHz, 1 KHz to 8 KHz) will be used, with a "switchover" at 1.4 KHz during plotting operations. The reduced bandwidth will also permit sampling data at a slower rate (i.e., 50 KHz vs. 100 KHz) as well as reduce the number of operations, digital files, analysis program, output plotting tapes, etc., by 1/3.

The selection of run numbers for processing and analysis was made from runs which were performed after the fixed transmitting strut at frame 58 was removed from the ship.

Noise Measurements in Purvis II: Outline  
of Proposed Analysis

D. Chase, Sept. 6, 1966

Broadly, two purposes may be distinguished for the noise measurements in Purvis II: first, to obtain noise levels on elements in typical positions and installations, together with correlations between neighboring similar elements, and thus to infer directly the noise levels for arrays in similar configurations; second, to determine the relative contributions of the various noise sources and properties of the corresponding noise fields in order to suggest noise-optimized configurations and assess the noise reduction possible by shielding elements from the flow. For the second purpose, the Purvis I measurements must be considered in parallel.

The flush-mounted TRG elements are especially pertinent to the former purpose. To achieve it, we examine the noise spectra for elements over the entire range of positions. For these identical elements we must investigate dependence on ship speed, distance aft (and the relation to interior noise sources), vertical position (proximity to water surface), ship maneuver, and sea state. Since the corresponding effective noise for an arbitrary array depends on the noise correlation among elements as well as the level for each element, narrow-band cross-correlations of the noise between neighboring elements must also be investigated.

- 2 -

The measured noise levels should be referred both to free-field and in-situ calibrations. The latter is appropriate so far as the acoustic configuration (baffle properties) conforms to that of ultimate interest, but the former permits inference of noise levels for different configurations without reference to the particular one used in the measurements.

We turn to the second purpose. The evident possible types and sources of noise are enumerated as follows.

1. acoustic

- a. machinery, other internal ship noise
- b. flow-excited hull, dome, or strut vibration
- c. cavitation (at screws, struts, protrusions)
- d. splash and other noise associated with ship-water-air interface
- e. bubbles
- f. natural turbulence (sea state)

2. turbulent-boundary-layer pressure fluctuations (transmitted acoustically if element is shielded from flow)

These contributions to the noise measured by an individual element will depend in various ways on the following salient variables:

1. frequency
2. speed
3. element size

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- 3 -

4. element location
5. type of element shielding (if any)
6. impedance of surrounding flow boundary
7. ship maneuver, sea state

Likewise, the cross-spectra of noise between elements, both in magnitude and phase, will differ distinctly for the acoustic and boundary-layer contributions. The same is true of the magnitude of the cross-spectra between noise on an element and acceleration at a nearby point of the flow boundary.\*

#### Calibrations

The use of free-field calibrations should be emphasized if and when these are available, especially with reference to the sea-chest mounted elements, since the acoustic configuration for these is rather special and not characteristic of a probable final system design. Until free-field calibrations are available, the over-side in-situ ones will be used wherever credible. If they are not credible in the instance of the sheathed elements in Sea Chest 1, e.g. if they differ greatly from one element to another, but noise measurements

---

\* Acceleration sensitivity of the element must also be considered in conjunction with readings of the accelerometers mounted on the rear masses of several elements.

- 4 -

for these elements at low speed coincide, the relative calibrations will tentatively be assumed equivalent among elements.

In evaluation of calibration results, those for neighboring identical elements will be compared. The appropriate extent and mode of frequency-averaging of the calibration curves must be established for noise data reduction.

We discuss briefly various sets of elements and data to be studied with regard to the noise sources and variables enumerated earlier.

Sea Chest 1 (sheathed elements: DI-DIC)

We compare reduced noise spectra among elements beneath layers of differing thicknesses; we compare these also for pairs of elements of same nominal thickness to eliminate influence of fore-aft position. Acoustic contribution to noise is expected to be nearly independent of depth. Boundary-layer contribution has distinguishable components which will be reduced to varying degrees dependent on different parameters. If wave numbers  $K \gg \pi R_o^{-1}$  do not contribute substantially, where  $R_o$  is element radius, and if wave number spectrum of pressure depends only weakly on  $K$  in the pertinent range, the noise spectrum is expected to be reduced relative to flush mounting in a rigid baffle by a factor  $\sim (R_o/R_e)^2$  if  $R_e \gtrsim R_o$ , where

$$R_e^{-2} = (1/4) [ (\omega/c)^2 + 1/2L^2 ],$$

$c$  is the order of the transverse (or possibly longitudinal) sound velocity in the material of the layer, and  $L$  is the layer thickness; the noise is expected not to be reduced if  $R_e \lesssim R_o$ , i.e. if

$$(\omega/c)^2 \gtrsim 4/R_o^2 - 1/2L^2.$$

Cross-spectra between various pairs of elements will be examined to help determine the predominant wave numbers in the pressure field at the depth  $L$  in question.

TRG elements at series of distances aft (large, flush elements: HF, LF, H)

Cross-spectra between neighboring elements at various distances aft will be examined to try to see in what frequency range the noise is predominantly attributable to the boundary layer and in what (higher) range to an acoustic field. In each range, the dependence on distance aft at fixed ship speed will be studied. In the range where boundary-layer noise is thought to predominate, it will be determined whether the noise decreases with distance aft in rough accord (given the observed frequency dependence) with two suggested alternative scaling forms for this type of noise. The variation with distance will be studied also where acoustic noise is thought to predominate. Cross-spectra of noise with acceleration measured at neighboring points will also be employed in distinguishing the acoustic contribution.

- 6 -

Noise spectra for elements at different vertical heights will be compared. In this connection, and also as a complicating factor in connection with dependence on distance aft, the intensity of turbulence, it is noted, may be significantly influenced by proximity to the motions generated at the ship-water-air interface. Along with an increased rms fluctuating velocity, an increased turbulent energy dissipation would also occur and perhaps be of greater importance on account of its relation to the decay of eddies and the associated non-convective effect; the latter may be significant for boundary-layer noise on large elements at high frequency.

Sea Chest 2 (flush window-mounted and dome-housed elements: G)

Here the comparison between noise spectra for the flush and the shielded elements is to be emphasized. A similar comparison between cross-spectra of noise on pairs of elements is important to indicate to what extent the wave number spectrum of pressure differs within the dome. Cross-spectra between noise and acceleration are likewise useful to indicate the relative contribution of acoustic sources to the noise on flush and shielded elements. Comparison of noise spectra with spectra from Purvis I will be used in consideration of the area-averaging effect. Noise spectra for flush window-mounted elements and those for neighboring, similar, flush hull-mounted elements will be compared to assess the probable effect of vibration of the sea-chest window.

- 7 -

Comparisons of noise spectra on various elements will be made with those on comparable elements in the U.S.S. Albacore measurements.

For all elements considered, cross-spectra between noise and ship motion will be examined with a view to evaluating the contribution of acoustic sources ~~lc - le~~ in the earlier enumeration.

September 27, 1966

Mr. J. Luistro  
Department of the Navy  
David Taylor Model Basin  
Washington, D.C. 20007

Re: Contract N0bsr 93023 PURVIS II  
Dear Mr. Luistro: Data Reduction

Enclosed is a copy of a draft of the PURVIS II Data Reduction order memo which I am having typed for transmission to our facility at NEL.

Programming has been started to permit conversion of the output tape to a single plot, including non-dimensional scales and with a log frequency abscissa.

It should be noted that the active transmission run data reductions are not fully specified. Complete active transmission data reduction requirements will be forwarded to you shortly.

Data completion time estimates for PURVIS II will be forwarded to you as soon as they are completed.

Very truly yours,

(Encl)

N. Nesenoff

NN/Mc  
cc: M. Baldwin, NEL  
H. Seberg, TRG  
W. Landauer, TRG  
W. Graham, TRG  
R. Newman, TRG  
J. Franz, DTMB  
I. Cook, DTMB

Enclosure

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INTER-OFFICE MEMORANDUM



September 27, 1966

TO: H. Seberg  
FROM: N. Nesenoff  
SUBJECT: PURVIS II DATA REDUCTION

Enclosed are the order runs for PURVIS II Data Reduction.

The first 25 items are for Sea States 0 (and 1) Headings with respect to sea of  $000^\circ$ , and speeds of 0, 10, 20, and 30 knots. Four pairs of hydrophones are used for the high frequency array, four pairs for the low frequency array, four pairs for the DTMB (D) Sea Chest 1 hydrophones, and two pairs for the GD (G) Sea Chest 2 hydrophone. (Table I)

Selected probability distribution curves are also specified for band limited signals in two bands;  $2Kc \rightarrow 3Kc$  and  $7Kc \rightarrow 8Kc$ .

Accelerometer spectra are also specified, but they can be performed on the GR wave analyzer since no "cross-correlations/or spectra are required.

In accordance with your recommendations for improved efficiency, we are specifying two processing bands.

200 cps  $\rightarrow$  2Kc  
1 Kc  $\rightarrow$  8Kc  
with switch over of curves at 1.4Kc.

The hydrophone pairs and accelerometers are specified for the HF (high frequency array), LF (low frequency array), D (Sea Chest 1), and G (Sea Chest 2) and are given in Table II.

The statistical data reduction program results in a total of 8 curves for a pair of hydrophones. These curves are summarized in Table III.

An additional set of curves is specified for headings with respect to sea "around-the-clock". These are taken at Sea State I, and at a speed of 20 knots. The runs are specified in Table I, items 26 through 31.

For the active transmission runs, a preliminary set of cross-correlations are specified for 16 speeds, 0, 5, 10, 15, 20, 22 knots; a heading with respect to sea of  $000^\circ$ , and sea state 2 and frequency combination F1. These are given in Table I items 32 through 37.

The active combinations are also given in Table II.

The presently available plots are to be made with priority given to:

1. Power Spectrum
2. Cross Power Spectrum
3. Correlations

Additional plotting programs are to be prepared to yield "dimensionless" plots in accordance with memo from Dave Chose of 9-13-66. Power Spectrum is to be plotted on a single curve (not 2 or 3 curves) with ordinate and abscissa in dimensionless form and plots to be made as logarithm of power (decibels) and logarithm of frequency. The cross-power will also have a dimensionless form and will be the subject of another memo by Dave Chose. It will, essentially be a linear plot of phase and frequency (same as now), and a linear plot of frequency versus normalized cross-spectrum, where frequency is in normalized form.

NN/Mc

cc: R. Newman  
D. Chase  
W. Landauer  
W. Graham  
M. Zullo

TABLE I  
PURVIS II Passive Data Processing

	Run No.	Date	Pairs	Speed	Sea State	Description	No. of Curves
Passive Acoustic Hulls	1	336	7/14	HF	0	Statistical Set	68
	2	338	7/14	HF	10	"	68
	3	340A	7/14	HF	20	"	68
	4	340	7/9	HF	20	1+	68
	5	342	7/15	HF	30	1+	68
	6	343	7/14	LF	0	"	68
	7	345	7/14	LF	10	"	68
	8	347A	7/14	LF	20	"	68
	9	347	7/9	LF	20	1+	68
	10	349	7/15	LF	30	1	68
Ampl. Distr.	11	343	7/14	HF5,LF3,H5	0	Ampl. dist. + cum (2 Bands 2Kc→3Kc 7Kc→8Kc)	12
	12	345	7/14	"	10	"	12
	13	347A	7/14	"	20	"	12
	14	347	7/9	"	20	1+	12
	15	349	7/15	"	30	1	12
	16	336	7/14	D	0	Statistical Set	76
	17	338	7/14	D	10	"	76
	18	340A	7/14	D	20	"	76
	19	340	7/9	D	20	1+	76
	20	342	7/15	D	30	1+	76
	21	343	7/14	G	0	"	36
	22	345	7/14	G	10	"	36
	23	347A	7/14	G	20	"	36
	24	347	7/9	G	20	1+	36
	25	349	7/15	G	30	1	36
	26	436	7/9	HF	20	1+	"
	27	536	7/9	HF	20	1+	"
	28	637	7/9	HF	20	1+	"
	29	443	7/9	LF	20	1+	"
	30	543	7/9	LF	20	1+	"
	31	644	7/9	LF	20	1+	"
	32	860	7/20	A	0	2	Active Curves A
	33	859	7/20	A	5	2	"(Table II)
	34	858	7/20	A	10	2	"
	35	857	7/20	A	15	2	"
	36	856	7/20	A	20	2	"
	37	862	7/20	A	22	2	"
							HW Sea
							090°
							180°
							270°
							090°
							180°
							270°
							000°
							000°
							000°
							000°
							000°

TABLE II  
Pairs

HF	<u>Pair</u>	<u>Curves</u>
	1. HF5 - HF4	16
	2. HF5 - HF3	16
	3. HF5 - HF12	16
	4. HF2 - H5	16
	5. A5	2 (Power Spectrum only*)
	6. A9	2 (Power Spectrum only*)
LF	1. LF3 - LF2	16
	2. LF3 - LF1	16
	3. LF12-LF11	16
	4. HF2 - H5	16
	5. A5	2 (Power Spectrum*)
	6. A9	2 (Power Spectrum*)
D	1. D1H - D2H	16
	2. D3H - D8H	16
	3. D4H - D9H	16
	4. D10H - HF10	16
	5. D1A	2 (Power Spectrum*)
	6. D2A	2 (Power Spectrum*)
	7. D3A	2 (Power Spectrum*)
	8. D4A	2 (Power Spectrum*)
	9. D9A	2 (Power Spectrum*)
	10. D10A	2 (Power Spectrum*)
G	1. G5 - G6	16
	2. G7 - G8	16
	3. G9 - G10	16
	4. A1	2 (Power Spectrum*)
	5. A4	2 (Power Spectrum*)

\* Power Spectrum can be analog GR plot

A      1. T2 - LF1  
       2. T4 - H5  
       3. T1 - HF5      T = Transmitting strut; use frequency combination F1.

Active Curves 'A'

Processing Consists of:

1. Received Signal O'graph plot (include scaling)

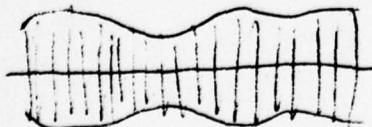
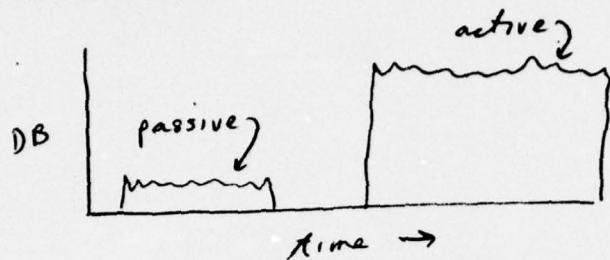


TABLE II (continued)

2. GR wave analyzer, 50 c.p.s. bandwidth at center frequency of transmitter.



3. Cross-correlation of transmitted signal and hydrophone filter at center frequency, 200 c.p.s. bandwidth.

4. Cross-correlation - Sample at 50Kc N = 2

Record length at 1/5 sec. Run for 15 time intervals for all three pairs at 20 knot speed only. Time intervals to be separated by 1 second.

TABLE III

<u>Pair XY</u>	<u>Statistical Set</u>
Auto Corr.	X
X . Corr.	Y
	XY
	YX
	X
	Y
	XY
	XY
	XY
8 Curves	

2 Bands (switch at 1.4Kc)  
200 c.p.s. → 2Kc  
1Kc → 8Kc

TABLE IV  
Summary, "Around-the-compass-runs"  
Various heading with respect to Sea at 20  
knots, Sea State 1

Run	Date	Record Combination	HW Sea	Sea State
436	7/9	1-1	090	1+
536	7/9	1-1	180	1+
637	7/9	1-1	270	1+
443	7/9	2-1	090	1+
543	7/9	2-1	180	1+
644	7/9	2-1	270	1+

TABLE V  
Summary, Preliminary Active Runs

HWS = 0° Sea State 2, Freq. Combo. F1, Rec. Combo 3-1

Run	Date	Speed	Rec. Combo.	HWS	SS	Freq. Combo
860	7/20	0	3-1	000	2	3-1
859	7/20	5	3-1	000	2	3-1
858	7/20	10	3-1	000	2	3-1
857	7/20	15	3-1	000	2	3-1
856	7/20	20	3-1	000	2	3-1
862	7/20	22	3-1	000	2	3-1

TABLE VI

Summary, Passive Runs  
 (Items 1 through 25, Table I)

Heading was  $0^\circ$  except at 0 knots  
 $HWS^\circ = 90^\circ$

Knots	Rec 1-1	Date	Sea State	Rec 2-1	Date	Sea State
0	336	7/14	0	343	7/14	0
10	338	7/14	0	345	7/14	0
20	340A	7/14	0	347A	7/14	0
20	340	7/9	1+	347	7/9	1+
30	342	7/15	1+	349	7/15	1

Subject PURVIS II Naval Architecture Series (Photographic)

Line No.	Col. A Run No.	Col. B Speed Knots	Col. C Date	Col. D Heading WRT Sea	Col. E Masker No.	Col. F Bow Wave Hose	Col. G Fish-eye Camera	Col. H RPM Port	Col. I True Wind Dir.	Col. J True Wind Vel.	Col. K Water T°	Col. L Sea State	Col. M Ships Course	Col. N Time & Index															
															1	2	3	4	5	6	7	8	9	10	11	12			
1	216 P	10	6/22	0°	2+4	Low	--	--	88	88	4	--	82	0	---	13:21:37													
2	217 P	15	6/22	0°	2+4	Low	XX	135	135	4	--	82	0	121°	13:43:24														
3	021	5	6/23	0°	---	---	--	043	4.5	035°	82	0-1	020	11:37:11															
4	022	10	6/23	0°	---	---	XX	088	088	4.5	035	82	0-1	020	11:53:30														
5	217	15	6/23	0°	2+4	Low	XX	--	135	135	4.5	035	82	0-1	020	12:08:37													
6	216	10	6/23	0°	2+4	Low	--	XX	088	088	4.5	035	82	0-1	020	12:24:46													
7	023	15	6/23	0°	---	---	--	--	135	135	4.5	035	82	0-1	020	12:40:18													
8	218	20	6/23	0°	2+4	Hi	XX	--	184	184	4.5	030	82	0-1	035	12:52:30													
9	116	20	6/23	0°	3	Med	--	--	184	184	4	050	82	0-1	059	14:06:30													
10	024	20	6/23	0°	---	---	XX	184	184	4	050	82	0-1	039	14:26:38														
11	115	15	6/23	0°	3	Med	--	--	135	135	4	050	82	0-1	057	14:58:13													
12	114	10	6/23	0°	3	Low	(Aft)	--	088	088	4	050	82	0-1	049	14:58:13													
13	223	15	6/23	270°	2+4	Low	(Aft)	XX	135	135	4	050	82	0-1	142	15:18:25													
14	029	15	6/23	270°	---	---	--	--	135	135	4	050	82	0-1	147	15:36:45													
15	121	15	6/23	270°	3	Med	(Aft)	XX	135	4	050	82	0-1	129	15:53:07														
16	122	20	6/23	270°	3	Med	--	--	184	184	9	064	82	0-1	125	16:07:27													
17	224	20	6/23	270°	2+4	Hi	--	--	184	184	9	064	82	0-1	113	16:26:10													
18	030	20	6/23	270°	---	---	(Aft)	XX	184	184	6	055	82	0-1	104	16:39:03													
19	028	10	6/23	270°	---	---	(Aft)	XX	088	088	5	035	82	0-1	090	17:01:13													
20	222	10	6/24	0°	2+4	Low	--	--	088	088	4	187	81	0	058	11:20:40													
21	025	25	6/24	0°	---	---	--	--	241	241	4	187	81	0	074	11:43:00													
22	117	25	6/24	0°	3	Med	--	--	241	241	4	187	81	0	074	11:58:10													
23	219	25	6/24	0°	2+4	Hi	--	--	241	241	4	187	81	0	055	12:21:10													
24	123	25	6/24	270°	3	Med	--	--	241	241	4	187	81	0	152	12:37:08													
25	225	25	6/24	270°	2+4	Low	--	--	241	241	4	187	81	0	123	12:52:40													

B026-47011/47013

## Subject

## PURVIS II Naval Architecture Series (Photographic)

Sheet 2 of 2

Line No.	Col. A Run No.	Col. B Speed Knots	Col. C Date Heading WRT Sea	Col. D Masker No.	Col. E Masker Rate	Col. F Bow Wave Hose	Col. G Fish-eye Camera	Col. H RPM Port Stbd.	Col. I True Wind Dir.	Col. J True Water T°	Col. K Water T°	Col. L Sea State	Col. M Ships Course	Col. N Time 6 Index
														(Aft)
1	031	25	6/24 270°	--	--	--	--	241	4	212	82	1	116°	---
2	026	30	6/24 0°	--	--	--	--	306	9	212	81	1	020	14:51:58
3	13	30	6/24 0°	3	H1	--	--	306	9	212	81	1	020	15:07:07
4	220	30	6/24 0°	2+4	Low	--	--	306	9	212	81	1	022	15:22:24
5	032	30	6/24 270°	--	--	--	--	306	9	212	81	1	122	15:36:42
6	226	30	6/24 270°	2+4	Low	--	--	306	9	212	81	1	116	15:52:33
7	124	30	6/24 270°	3	H1	--	--	306	9	212	81	1	122	16:05:02
8	043	20	6/24 090°	--	--	--	--	184	7	125°	81	1	301	16:25:03
9	960	0	6/25 Ship's Motion	Recording Only	From 10:53:00 to 11:28:00									
10	041	10	6/25 90°	--	--	--	--	088	10	055	82°	0	358	11:36:12
11	042	15	6/25 90°	--	--	(Aft)	--	135	10	055	82	0	350	11:52:32
12	044	25	6/25 90°	--	--	(Aft)	--	241	10	055	82	0	003	12:09:44
13	134	20	6/25 90°	3	Med	--	--	184	10	045	82	1	008	12:28:02
14	236	20	6/25 270°	2+4	Low	--	--	184	10	045	82	1	188	12:43:39
15	128	20	6/25 180°	3	Low	--	--	184	13	110	82	1	323	13:00:59
16	036	20	6/25 180°	--	--	(Aft)	--	184	13	110	82	1	316	13:20:00
17	230	20	6/25 180°	2+4	Low	--	--	184	13	110	82	1	325	13:34:45
18	049	15	6/25 Full L Rudder	--	--	--	--	135	6	124	82	0	---	15:14:55
19	048	15	6/25 Full R Rudder	--	--	--	--	135	6	124	80	0	---	15:25:20
20	053	25	6/25 Full L Rudder	--	--	--	--	241	6	124	82	0	---	15:41:31
21	052	25	6/25 Full R Rudder	--	--	--	--	241	6	124	82	0	---	15:53:45

- NOTES:
1. Record combination 1 Rev 0 used for all runs except run 960 (Ship's Motion)
  2. Chesapeake Prop (Xmitter) extended 3 feet for all runs of June 25.

APPENDIX B-1  
PURVIS II ACOUSTIC RUNS BY DATE

Date	Run No.	Type	Speed	Heading	Record Comb.
28 June	163	Overside Cal.	0	---	1-1
28 June	964	Sondome Damage Noise Effect	5	180	4-0
28 June	965	"	10	180	4-0
28 June	966	"	15	180	4-0
28 June	967	"	20	180	4-0
28 June	968	"	27	180	4-0
29 June	969	Elec. Calibration	0	0	Recorder No. 4 only
29 June	738	Transmission	0	000	3-1
30 June	739	Transmission Ship Motion Cal.	5	0	3-1
30 June	766	Transmission	5	0	3-1
30 June	746	"	5	90	3-1
30 June	755	"	15	180	3-1
30 June	756	"	20	180°	3-1
30 June	740	"	10	0	3-1
30 June	747	"	10	90	3-1
30 June	754	"	10	180	3-1
30 June	761	"	10	270	3-1
30 June	767	"	10	0	3-1
30 June	768	"	15	0	3-1
30 June	741	"	15	0	3-1
30 June	769	"	20	0	3-1
30 June	763	"	20	270	3-1
30 June	762	"	15	270	3-1
1 July	742	"	20	000	3-1
1 July	743	"	25	000	3-1
1 July	744	"	30	000	3-1
1 July	749	"	20	090	3-1
1 July	750	"	25	090	3-1
1 July	765	"	30	270	3-1
1 July	757	"	25	180	3-1
1 July	751	"	30	90	3-1
1 July	758	"	30	180	3-1
1 July	762	"	15	270	3-1
1 July	764	"	25	270	3-1
1 July	770	"	25	000	3-1
1 July	771	"	30	000	3-1
1 July	772	"	25	000	3-1
1 July	773	"	25	000	3-1
1 July	774	"	25	000	3-1
1 July	820	"	20	360 turn 1/2 right	3-1
1 July	821	"	20	360 turn 1/2 left	3-1
1 July	822	"	20	360° turn F. right	3-1
1 July	823	"	20	360° turn F. left	3-1

PURVIS II ACOUSTIC RUNS BY DATE  
(Continued)

Date	Run No.	Type	Speed	Heading	Record Comb.
1 July	820	Transmission	20	000	3-1
1 July	831	"	20	000	3-1
1 July	832	"	20	000	3-1
1 July	833	"	20	000	3-1
1 July	834	"	20	000	3-1
1 July	835	"	20	000	3-1
1 July	838	"	20	000	3-1
1 July	842	" Picture	25	360 turn F. right	3-1
1 July	843	Transmission	25	360 turn F. left	3-1
2 July	775	"	20	000	3-1
2 July	776	"	20	000	3-1
2 July	777	"	20	000	3-1
2 July	970	Passive	17	000	4-1
2 July	971	"	19	000	4-1
2 July	972	"	21	000	4-1
2 July	973	"	23	000	4-1
2 July	974	"	25	000	4-1
2 July	975	"	20	000	4-1
5 July	350	Passive Cal. for Transmission	5	000	5-0
5 July	351	"	10	000	5-0
5 July	352	"	15	000	5-0
5 July	353	"	17	000	5-0
5 July	354	"	20	000	5-0
5 July	782	Transmission	20	000	5-0
5 July	781	"	17	000	5-0
5 July	780	"	15	000	5-0
5 July	778-741	"	5	000	5-0
5 July	779-742	"	10	000	5-0
5 July	780-743	"	15	000	5-0
5 July	781-748	"	17	000	5-0
5 July	782-749	"	20	000	5-0
6 July	358	Passive	5	000	5-0
6 July	355	"	21	000	5-0
6 July	356	"	23	000	5-0
6 July	357	"	25	000	5-0
6 July	783/750	Transmission	21	000	5-0
6 July	784/763	"	23	000	5-0
6 July	785/764	"	25	000	5-0
6 July	971-1-3	Overside Cal.	0	---	2-1
6 July	972	"	0	---	2-0
6 July	973-1-5	"	0	---	2-1
7 July	974-1-3	"	0	---	3-1
7 July	975-1-3	"	0	---	3-1
7 July	976-1-3	"	0	---	1-1
7 July	9 7-1-3	"	0	---	1-1

PURVIS II ACOUSTIC RUNS BY DATE  
(Continued)

Date	Run No.	Type	Speed	Heading	Record	Comb.
7 July	978-1-3	Overside Cal.	0	---	1-1	
7 July	979-1-3	"	0	---	1-1	
7 July	980-1-3	"	0	---	1-1	
9 July	340	Passive	20	000	1-1	
9 July	341	"	25	000	1-1	
9 July	346	"	15	000	1-1	
9 July	347	"	20	000	2-1	
9 July	348	"	25	000	2-1	
9 July	436	"	20	090	1-1	
9 July	443	"	20	090	2-1	
9 July	535	"	15	180	1-1	
9 July	536	"	20	180	1-1	
9 July	543	"	20	180	2-1	
9 July	637	"	20	270	1-1	
9 July	644	"	20	270	2-1	
9 July	787-756	Transmission	20	180	3-1	
9 July	995	Ship Motion	0	000	3-1	
9 July	784A	Transmission	20	270	3-1	
9 July	779A	"	20	000	3-1	
9 July	782A	"	20	090	3-1	
9 July	778A	"	15	000	3-1	
9 July	780A	"	25	000	3-1	
9 July	339	Passive	15	000	1-1	
14 July	336	"	0	000	1-1	
14 July	337	"	5	000	1-1	
10 July	996-1-3	Electrical Cal.	0	---	1-1	
10 July	981-1-3	Overside Cal.	0	000	1-1	
10 July	982-1-3	Overside Cal.	0	---	1-1	
10 July	983-1-3	"	0	---	1-1	
10 July	997	Transmission/Cal.	0	---	3-1	5-0
10 July	997	"	0	---	5-0	3-1
11 July	999	Electrical Cal.	0	---	2-1	
11 July	984-1-3	Overside Cal.	0	---	2-1	
11 July	985-1-3	"	0	---	2-1	
11 July	986-1-3	"	0	---	2-1	
11 July	987-1-3	"	0	---	2-1	
11 July	988-1-3	"	0	---	2-1	
11 July	989-1-3	"	0	---	2-1	
11 July	950	Transmission/Cal.	0	---	3-1	
12 July	990-1-3	Overside Cal.	0	---	3-1	
12 July	991-1-3	"	0	---	3-1	
14 July	338	Passive	10	000	1-1	
14 July	339	"	15	000	1-1	
14 July	339-A	"	15	000	1-1	
14 July	340-A	"	20	000	2-1	
14 July	343	"	0	000	2-1	
14 July	344	"	5	000	2-1	

PURVIS II ACOUSTIC RUNS BY DATE  
(Continued)

Date	Run No.	Type	Speed	Heading	Record Comb.
14 July	345	Passive	10	000	2-1
14 July	346-A	"	15	000	2-1
14 July	347-A	"	20	000	2-1
14 July	793-738	Transmission	0	000	3-1
14 July	992	Electrical Cal.	0	000	2-1 & 1-1
15 July	993	"	0	---	2-1 & 1-1
15 July	341-A	Passive	25	000	1-1
15 July	342	"	30	000	1-1
15 July	348-A	"	25	000	2-1
15 July	349	"	30	000	2-1
15 July	437	"	25	090	1-1
15 July	438	"	30	090	1-1
15 July	444	"	25	090	2-1
15 July	445	"	30	090	2-1
15 July	449/44	"	20	090	2-1
15 July	537	"	30	180	1-1
15 July	544	"	25	180	2-1
15 July	551	"	25	180	1-1
15 July	545	"	30	180	2-1
15 July	549/536		15	180	1-1
15 July	638	Passive	25	270	1-1
15 July	639	"	30	270	1-1
15 July	645	"	25	270	2-1
15 July	646	"	30	270	2-1
15 July	649-639	"	20	270	1-1
15 July	650-644		20	270	2-1
15 July	794	Passive	20	000	3-1
15 July	796/794	Transmission	20	000	3-1
15 July	797	Transmission	10	000	3-1
17 July	435	Passive	15	090	1-1
17 July	441	"	10	090	2-1
17 July	442	"	15	090	2-1
17 July	448/436	"	20	090	1-1
17 July	531	"	10	180	1-1
17 July	541	"	10	180	2-1
17 July	542	"	15	180	2-1
17 July	550/535	"	15	180	1-1
17 July	552/543	"	20	180	2-1
17 July	634	"	5	270	1-1
17 July	635	"	10	270	1-1
17 July	636	"	15	270	1-1
17 July	641	"	5	270	2-1
17 July	642	"	10	270	2-1
17 July	643	"	15	270	2-1
17 July	753	Transmission	5	180	3-1
17 July	760	"	5	270	3-1
17 July	795	"	15	000	3-1

PURVIS II ACOUSTIC RUNS BY DATE  
(Continued)

Date	Run No.	Type	Speed	Heading	Record Comb.
17 July	839	Transmission	20	000	3-1
17 July	994-1-3	Electrical Cal. Ship Motion	4	000	5-0 Cal.
17 July	762-A	Transmission	15	270	3-1
20 July	851	Electrical (4 part)	--	---	1 & 4 1-1 2 & 3 2 - 1
20 July	852	Passive Ship Motion	--	---	1-1
20 July	855	Transmission	25	000	3-1
20 July	858	"	10	000	3-1
20 July	859	"	5	000	3-1
20 July	860	"	0	000	3-1
20 July	861	"	22	000	3-1
20 July	862	"	22	000	3-1
20 July	863	"	20	000	3-1
20 July	864	"	15	000	3-1
20 July	865	"	10	000	3-1
20 July	866	"	5	000	3-1
20 July	867	"	0	000	3-1
20 July	868	"	22	000	3-1
20 July	869	"	20	000	3-1
20 July	870	"	15	000	3-1
20 July	871	"	10	000	3-1
20 July	872	"	5	000	3-1
20 July	873	"	0	000	3-1
20 July	874	"	22	000	3-1
20 July	875	"	20	000	3-1
20 July	876	"	15	000	3-1
20 July	877	"	10	000	3-1
20 July	878	"	5	000	3-1
20 July	879	"	0	000	3-1

## Subject PURVIS II Acoustic Series

## Sheet 1 of 6

Line No.	Col. A Run No.	Col. B Probe Ext. ft.	Date	Col. C Speed-Kts.	Col. D Record Comb.	Col. E Heading to Sea	Col. F Masker State	Col. G Transmit freq. Comb.	Col. H RPM Port Srbd.	Col. I Relative Wind Vel.	Col. J Relative wind direction	Col. K Ships Course	Col. L Water Temp.
1	336	0	7/14	0	1-1	090	0	--	0	0	2 KTS	090	---
2	337	0	7/14	5	1-1	000	0	--	043	043	7	030	090
3	338	0	7/14	10	1-1	000	0	--	088	088	14	010	090
4	339	4.0	7/14	15	1-1	000	1+	--	135	135	27	350	120
5	339-A	0.5	7/14	15	1-1	000	0	--	135	135	20	010	090
6	340	4.0	7/14	20	1-1	000	1+	--	184	184	25	355	125
7	340-A	0	7/14	20	1-1	000	0	--	184	184	30	350	125
8	341	4.0	7/14	25	1-1	000	2	--	241	241	38	355	115
9	341-A	0.0	7/15	25	1-1	000	1-1	--	241	241	25	000	130
10	342	0	7/15	30	1-1	000	1-1	--	306	306	40	000	136
11	343	0	7/14	0	2-1	090	0	--	0	0	2	090	---
12	344	0	7/14	5	2-1	000	0	--	043	043	7	030	090
13	345	0	7/14	10	2-1	000	0	--	088	088	14	010	090
14	346	4.0	7/9	15	2-1	000	1+	--	135	135	27	350	120
15	346-A	0.5	7/14	15	2-1	000	0	--	135	135	20	010	090
16	347	4.0	7/9	20	2-1	000	1+	--	184	184	30	350	125*
17	347-A	0	7/14	20	2-1	000	-0	--	184	184	25	350	125
18	348	4.0	7/9	25	2-1	000	2	--	241	241	38	355	115
19	348-A	0	7/15	25	2-1	000	1	--	241	241	25	000	130
20	349	0	7/15	30	2-1	000	1	--	306	306	40	000	136
21	350	0	7/5	5	5-0	000	0	--	043	043	6	340	245
22	351	0	7/5	10	5-0	000	0	--	0	0	6	331	245
23	352	0	7/5	15	5-0	000	0	--	135	135	14	332	245
24	353	0	7/5	17	5-0	000	0	--	154	153	24	334	245
25	354	0	7/5	20	5-0	000	0	--	184	184	25	340	245
26	355	0	7/6	21	5-0	000	0	--	195	195	25	000	240
27	356	0	7/6	23	5-0	000	0	--	217	217	30	000	240
28	357	0	7/6	25	5-0	000	0	--	241	241	32	000	240
29	358	0	7/6	5	5-0	000	0	--	043	043	8	350*	240

Subject No.	Line No.	Col.A Run No.	Col.B Probe Ext. ft.	Col.C Date Record Comb. Kts.	Col.D Record Comb. Kts.	Col.E Heading to Sea	Col.F Sea State	Col.G Transmit Freq. Comb.	Col.H RPM Port	Col.I Relative wind Vel.	Col.J Relative wind Direction	Col.K Ships Course	Col.L Water Temp.		
1	435	0	7/14	15	1-1	090	1	--	--	135	0-1	310	050	80	
2	436	4.0	7/14	20	1-1	090	1+	--	--	184	184	025	030	80	
3	437	0	7/15	25	1-1	090	1	--	--	241	241	28	010	045	82
4	438	0	7/15	30	1-1	090	1	--	--	306	306	34	010	040	82
5	441	0	7/17	10	2-1	090	1	--	--	088	088	0-1	14	050	80
6	442	0	7/17	15	2-1	090	1	--	--	135	135	0-1	310	050	80
7	443	4.0	7/9	20	2-1	090	1+	--	--	184	184	24	025	030	80
8	444	0	7/15	25	2-1	090	1	--	--	241	241	28	010	045	82
9	445	0	7/15	30	2-1	090	1	--	--	306	306	34	010	040	82
10	448/436	0	7/17	20	1-1	090	1	--	--	184	184	0-1	040	055	80
11	449/443	0	7/15	20	2-1	090	1	--	--	184	184	23	019	045	82
12	531	0	7/17	10	1-1	180	1	--	--	088	088	10	280	320	80
13	535	4.0	7/9	15	1-1	180	1+	--	--	135	135	0	090	315	80
14	536	4.0	7/9	20	1-1	180	1+	--	--	184	184	4	020	315	80*
15	537	0	7/15	30	1-1	180	1	--	--	306	306	22	000	310	82
16	541	0	7/17	10	2-1	180	1	--	--	088	088	10	280	320	80
17	542	0	7/17	15	2-1	180	1	--	--	135	135	15	310	320	80
18	543	4.0	7/9	20	2-1	180	1+	--	--	184	184	4	020	315	80
19	544	0	7/15	25	2-1	180	1	--	--	241	241	8	334	310	82
20	545	0	7/15	30	2-1	180	1	--	--	306	306	22	000	310	82
21	549/536	0	7/15	20	1-1	180	1	--	--	---	---	---	---	---	--
22	550/535	0	7/17	15	1-1	180	1	--	--	135	135	15	310	320*	80
23	551/536	0	7/18	25	1-1	180	1	--	--	241	241	8	334	310	82
24	552/5431	0	7/17	20	2-1	180	1	--	--	784	784	19	315	320*	80

## Subject

Sheet 3 of 6

Line No.	Col. A Run No.	Col. B Probe Ext. ft.	Date	Col. C Speed- Rts.	Col. D Record Comb.	Col. E Heading to Sea	Col. F Sea State	Col. G Marker Freq. Comb.	Col. H RPM Port	Col. I Relative Wind Vel.	Col. J Relative wind Direction	Col. K Ships Course	Col. L Water Temp.	
1	634	0	7/12	5	1-1	270	1	-	043	043	16	345	230	80°
2	635	0	7/12	10	1-1	270	1	-	088	088	22	342	230	80
3	636	0	7/12	15	1-1	270	1	-	135	135	28	350	230	80
4	637	4.0	7/9	20	1-1	270	1+	-	184	184	5	320	225	80
5	638	0.0	7/15	25	1-1	270	1	-	261	241	15	331	230	82
6	639	0	7/15	30	1-1	270	1	-	306	306	20	330	225	82
7	641	0	7/12	5	2-1	270	1	-	043	043	16	35°	230	80
8	642	0	7/17	10	2-1	270	1	-	088	088	22	342°	230	80
9	643	0	7/17	15	2-1	270	1	-	135	135	28	350	230	80
10	644	4.0	7/9	20	2-1	270	1+	-	184	184	5	320	225	80
11	645	0	7/15	25	2-1	270	1	-	241	241	14	330	225	82°
12	646	0	7/15	30	2-1	270	1	-	306	306	20	330	225	82
13	649/639	0	7/15	20	1-1	270	1	-	184	184	8	320	225	82
14	650/644	0	7/15	20	2-1	270	1	-	-	-	-	-	-	-
15	651													
16	738	5.0	6/29	0	3-1	000	1	-	F1	-	-	-	-	-
17	739	5.0	6/30	5	3-1	000	1	-	F1	043	15	020	130	79°
18	740	5.0	6/30	10	3-1	000	0	-	F1	088	20	000	135	79°
19	741	5.0	6/30	15	3-1	000	0	-	F1	135	30	355°	140	79°
20	742	5.0	7/1	20	3-1	000	0	-	F1	184	30	000	160	80°
21	743	4.0	7/1	25	3-1	000	0	-	F1	241	35	355	160	80°
22	744	4.0	7/1	30	3-1	000	0	-	F1	306	39	355	160	80°
23	746	5.0	6/30	5	3-1	090	1	-	F1	043	5	100	030	79°
24	747	5.0	6/30	10	3-1	090	0	-	F1	306	32	020	070	80°
25	749	5.0	7/1	20	3-1	090	0	-	F1	184	18	030	055	80°
26	750	4.0	7/1	25	3-1	090	0	-	F1	241	32	005	090	80°
27	751	4.0	7/1	30	3-1	090	0	-	F1	306	32	020	070	80°
28	753	5.0	7/17	5	3-1	180	1	-	F1 or F6	043	11	260	320	80°
29	754	5.0	6/30	10	3-1	180	0	-	F1	088	1	170	315	79°
30	755	5.0	6/30	15	3-1	180	1	-	F1	135	1	310	325	79°

## Sheet 4 of 6

Sublec.

Line No.	Col.A Run No.	Col.B Probe Ext. ft.	Date	Col.C Speed-Kts.	Col.D Record Comb.	Col.E Heading to Sea	Col.F Sea State	Col.G Masker Freq. Comb.	Col.H Transmit Port	Col.I RPM Stbd.	Col.J Relative Wind Dir.	Col.K Ships Course	Col.L Water Temp.	Col.M	Col.N Comments
1	756	5.0	6/30	20	3-1	180	1	-	F1	184	1	045	325	79°	
2	757	4.0	7/1	25	3-1	180	0	-	F1	241	20	015	000	80°	
2	758	4.0	7/1	30	3-1	180	0	-	F1	306	306	16	016	340	80°
4	760	5.0	7/17	5	3-1	270	1	-	F1 or F6	043	18	350	230	80°	
5	761	5.0	6/30	10	3-1	270	0	-	F1	088	18	290	225	79°	
6	762	5.0	7/1	15	3-1	270	0	-	F1	135	5	315	240	80°	
2	763	5.0	6/30	20	3-1	220	0	-	F1	184	184	8	310	235	79°
8	764	4.0	7/1	25	3-1	270	0	-	F1	241	14	064	290	80°	
9	765	4.0	7/1	30	3-1	220	0	-	F1	306	19	325	250	80°	
10	766	5.0	6/30	5	3-1	000	1	3M	F1	043	15	020	130	79°	
11	767	5.0	6/30	10	3-1	000	0	3M	F1	088	22	000	135	79°	
12	768	5.0	6/30	15	3-1	000	0	3M	F1	135	135	30	355	140	79°
13	769	5.0	6/30	20	3-1	000	0	3M	F1	184	184	33	358	145°	79°
14	770	4.0	7/1	25	3-1	000	0	3M	F1	241	241	35	355	160	80°
15	771	4.0	7/1	30	3-1	000	0	3M	F1	306	38	355	160	80°	
16	772	4.0	7/1	25	3-1	000	0	-	F2	241	21	030	180	80°	
17	773B	4.0	7/1	25	3-1	000	0	-	F3	241	241	30	345	165	80°
18	774	4.0	7/1	25	3-1	000	0	-	F4	241	241	30	345	165	80°
19	775	5.0	7/2	20	3-1	000	0	-	F2	184	184	24	320	252	80°
20	776	5.0	7/2	20	3-1	000	0	-	F3	184	184	24	320	252	80°
21	777	5.0	7/2	20	3-1	000	0	-	F4	184	184	24	320	340	80°
22	778/741	5.0	7/5	5	5-0	000	0	-	F5	043	6	343	260	82°	
23	779/742	5.0	7/5	10	5-0	000	0	-	F5	038	088	11	345	260	82°
24	780/743	5.0	7/5	15	5-0	000	0	-	F5	135	135	15	342	260	82°
25	781/748	5.0	7/5	17	5-0	000	0	-	F5	154	154	21	340	260	82°
26	782/749	5.0	7/5	20	5-0	000	0	-	F5	184	184	25	340	245	82°
27	783/750	4.0	7/6	21	5-0	000	0	-	F5	195	195	26	000	24	81°
28	784/763	4.0	7/6	23	5-0	000	0	-	F5	217	217	29	355	240	81°
29	785/764	4.0	7/6	25	5-0	000	0	-	F5	241	241	29	350	240	81°
30	787/756	4.0	7/9	20	3-1	180	1+	-	F1	184	184	4	020	345	80°

Line No.	Col.A Run No.	Col.B Probe Ext. ft.	Date	Col.C Speed- Kts.	Col.D Record Comb.	Col.E Heading to Sea	Col.F Sea State	Col.G Masker Freq. Comb.	Col.H Transmit Port	Col.I Relative Wind Vel.	Col.J Relative wind Direction	Col.K Ships Course	Col.L Water Temp.	Col.M Comments	Col.N
1	792/738	7/14	0	3-1	000	0	-	F1,2,3,4	0	2	.090	0	83		
2	794	7/15	1	3-1	000	1	-	F1,2,3,4	184	30	.350	130	82		
3	795	7/17	1	3-1	000	1	-	F1,2,3,4	135	10	.050	140	80		
4	796/794	7/15	1	3-1	000	1	-	F1,F2	184	28	.000	130	82		
5	797	7/15	1	3-1	000	1	-	F2,F1	088	19	.357	130	82		
6	820		0	3-1	000	0	-	F1	184	19	.020	.050	80		
7	821	7/1	0	3-1	000	0	-	F1	184	8	.230	.270	80		
8	822	7/1	0	3-1	000	0	-	F1	184	-	-	Widest	80		
9	823	7/1	0	3-1	000	0	-	F1	184	-	-	Rubber	80		
10	830	7/1	0	3-1	000	0	-	F1	184	29	.350	.170	80		
11	831	7/1	0	3-1	000	0	-	F1	184	11	.020	.000	80		
12	832	7/1	0	3-1	000	0	-	F1	184	12	.020	.345	80		
13	833	7/1	0	3-1	000	0	-	F1	184	12	.020	.345	.80		
14	834	7/1	0	3-1	000	0	-	F1	184	12	.020	.345	.80		
15	835	7/1	0	3-1	000	0	-	F1	184	12	.020	.345	.80		
16	838	7/1	0	3-1	000	0	4L	F1	184	12	.020	.345	.80		
17															
18	842	7/1	0	3-1	000	0	-	F1	241	13	.330°	.230°	80		
19	843	7/1	0	3-1	000	0	-	F1	241	20	.015	.000	80		
20	963	6/28	1	1-1	-	1	-		043	14	.135	.350	.81		
21	964	6/28	1	4-0	180	1	-		088	8	.125	.350	.81		
22	965	6/28	1	4-0	180	1	-		135	0	.125	.350	.81		
23	966	6/28	1	4-0	180	1	-		184	10	.050	.350	.81		
24	967	6/28	1	4-0	180	1	-		267	15	.030	.350	.81		
25	968	6/28	1	4-0	180	1	-		13	.320	.252	.252	.80		
26	969	6/29	0	4-1	000	0	-		13	.320	.252	.252	.80		
27	970	7/2	0	4-1	000	0	-		13	.320	.252	.252	.80		
28	971	7/2	0	4-1	000	0	-		13	.320	.252	.252	.80		
29	972	7/2	0	4-1	000	0	-		13	.320	.252	.252	.80		

APPENDIX B-2 RUN SUMMARY-ACOUSTIC SERIES

Subject

## Sheet 6 of 6

Line No.	Col.A Run No.	Col.B Probe Ext. ft.	Col.C Sped-Kts.	Col.D Record Comb.	Col.E Heading to Sea	Col.F Sea State	Col.G Masker Freq. Comb.	Col.H RPM Port	Col.I RPM Stbd.	Col.J Relative Wind Vel.	Col.K Ships Course	Col.L Water Temp.	Col.M Col.N COMMENTS
1	973	7/2	23	4-1	000	0	-	-	-	13	320	252	80
2	974	7/2	25	4-1	000	0	-	-	-	13	320	252	80
3	975	7/2	21	4-1	000	0	-	-	-	13	320	352	80
4	975A	7/7	0	3-1	000	0	-	-	-	11 kts	135	135	81
5	995	7/9	0	5 only	000	1	-	-	-	11 kts	135	135	81
6	992	7/14	0	only	000	0	-	-	-	-	-	-	-
7	994	7/17	4	5 only	000	1	-	034	034	-	050	140	80
8	786A	7/9	20	3-1	270	1+	-	F1	184	184	5	320	225
9	779A	7/9	20	3-1	000	1+	-	F1	184	184	26	350	135
10	782A	7/9	20	3-1	090	1+	-	F1	184	184	24	025	030
11	778A	7/9	15	3-1	000	1+	-	F1	135	135	27	350	120
12	780A	7/9	25	3-1	000	2	-	F1	241	241	38	355	115
13	762A	7/9	15	3-1	270	1	-	F1 or F6	135	135	29	355	230
14	855	7/20	25	1-1	0	2	-	F1	241	241	7kts	160	230
15	856	7/20	20	3-1	0	2	-	F1	241	241	7kts	160	230
16	857	7/20	15	3-1	0	2	-	F1	241	241	7kts	160	230
17	858	7/20	10	3-1	0	2	-	F1	088	088	7kts	160	230
18	859	7/20	5	3-1	0	2	-	F1	043	043	7kts	160	230
19	860	7/20	0	3-1	0	2	-	F1	000	000	7kts	160	230
20	861	7/20	22	3-1	0	2	-	F2	206	206	7kts	160	230
21	862	7/20	22	3-1	0	2	-	F1	206	206	7kts	160	230
22	863	7/20	20	3-1	0	2	-	F2	195	195	7kts	160	230
23	864	7/20	15	3-1	0	2	-	F2	135	135	7kts	160	230
24	865	7/20	10	3-1	0	2	-	F2	088	088	7kts	160	230
25	866	7/20	5	3-1	0	2	-	F2	043	043	7kts	160	230
26	867	7/20	0	3-1	0	2	-	F2	000	000	7kts	160	230
27	868	7/20	22	3-1	0	2	-	F3	206	206	11kts	000	175
28	869	7/20	20	3-1	0	2	-	F3	195	195	11kts	000	175

B026-47011/47013

APPENDIX C

RECORDING COMBINATIONS

## PURVIS II RECORDING COMBINATION 1 REV 0

(REPLACES PURVIS II RECORDING COMBINATION 1 REV 0)

RECORDER NO.	RECORDER NO. 1				RECORDER NO. 2				RECORDER NO. 3				RECORDER NO. 4				
	TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				
	MARK	ON	STA.	CONN.	MARK	ON	STA.	CONN.	MARK	ON	STA.	CONN.	MARK	ON	STA.	CONN.	
1	1	1	2	1	HF-1	P1007	10	1	2	10	HF-10	P1060	60	1	4	1	D1H
2	7	1	2	7	HF-7	P1030	35	2	4	5	3-5	P1020	61	1	4	2	D2H
3	2	1	2	2	HF-2	P1011	11	1	2	11	HF-11	P1031	62	1	4	3	D3H
4	8	1	2	8	HF-8	P1002	43	2	4	13	A-1	999	63	1	4	4	D4H
5	2	1	2	3	HF-3	P1076	12	1	2	12	HF-12	P1009	64	1	4	5	D5H
6	9	1	2	9	HF-9	P1014	38	2	4	8	G-8	P1071	65	1	4	6	D6H
7	4	1	2	4	HF-4	P1036					SPARE(Cal)		66	1	4	7	D7H
8	29	2	2	14	A-7	966	44	2	4	14	A-4	995	67	1	4	8	D8H
9	5	1	2	5	HF-5	P1027	13	1	2	13	HF-13	P1008	68	1	4	9	D9H
10	16	2	1	LF-1	P1015	50	3	2	5	H-5	P1046	69	1	4	10	D10H	
11	6	1	2	6	AF-6	P1019					SPARE		Spare (Cal)				
12	14	1	2	14	A-5	1002	56	3	2	11	A-9	997	SPARE				

- Notes:
- During electrical calibrations, CAL signal is applied to tracks indicated as spare (CAL).
  - CAL signal to DTMF signals are patched via Q20 to J161 on Mac panel to CAL T's on DTMF amps.

## PURVIS II RECORDING COMBINATION 2 REV 0

(REPLACES PURVIS II RECORDING COMBINATION 2 REV 0)

RECORDED NO.	RECORDED NO. 1				RECORDED NO. 2				RECORDED NO. 3				RECORDED NO. 4				
	TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				
NO.	SCA NO.	STA NO.	CONN. NO.	ELEMENT NO.	SERIAL NO.	SCA NO.	STA NO.	CONN. NO.	ELEMENT NO.	SERIAL NO.	SCA NO.	STA NO.	CONN. NO.	ELEMENT NO.	SERIAL NO.		
1	21	2	2	6	LF-6	P1063			SPARE (CAL)		31	2	4	1	G-1	P1095	
2	20	2	2	5	LF-5	P1043	64	1	4	5	32	2	4	2	G-2	P1073	
3	2	1	2	2	HF-2	P1011	24	2	9	LF-9	P1068	33	2	4	3	G-3	P1021
4	19	2	2	4	LF-4	P1001			SPARE		35	2	4	5	G-5	P1020	
5	3	1	2	3	HF-3	P1076	25	2	10	LF-10	P1012	38	2	4	8	G-8	P1071
6	18	2	2	3	LF-3	P1010	65	1	4	6	D6H	34	2	4	4	G-4	P1098
9	22	2	2	7	LF-7	P1029	26	2	11	LF-11	P1062	36	2	4	6	G-6	P1042
10	17	2	2	LF-2	P1034				SPARE		37	2	4	7	G-7	P1045	
11	23	2	2	8	LF-8	P1059	27	2	12	LF-12	P1050	44	2	4	14 (CAL)	A-4	995
12	16	2	1	LF-1	P-1015	46	2	6	9	H-1	P1071	40	2	4	10	G-10	P1052
13	29	2	2	14	A-7	966	28	2	13	LF-13	P1063	41	2	4	11	A-2	994
14	14	1	2	14	(CAL) A-5	1002			SPARE		42	2	4	12	A-3	993	

NOTES: Same as record combination 1

C-3

(CAL) indicates CAL signal applied in EL CAL panels

PREPARED BY: R. Newman  
DATE: 25 June 1966

**PURVIS II RECORDING COMBINATION 3 REV 0**

(REPLACES PURVIS II RECORDING COMBINATION 3 REV 0)

EFFECTIVE DATE \_\_\_\_\_

TRACK NO.	RECORDER NO. 1				RECORDER NO. 2				RECORDER NO. 3				RECORDER NO. 4											
	TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION											
	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.								
1	1	1	2	1	HF-1	P1007	51	3	2	6	H-6	P1061	16	2	2	1	LF-1	P1015	49	2	6	12	H-4	P1057
2	7	1	2	7	HF-7	P1030	35	2	4	5	G-5	P1020	21	2	2	6	LF-6	P1063	60	1	4	1	D1H	
3	2	1	2	2	HF-2	P1011	55	3	2	10	H-10	P1049	17	2	2	2	LF-2	P1034	61	1	4	2	D2H	
4	8	1	2	8	HF-8	P1002	43	2	4	13	A-1	999	64	1	4	5	D5H		25	2	2	10	LF-10	P1012
5	3	1	2	3	HF-3	P1076	54	3	2	9	H-9	P1009	65	1	4	6	D6H		26	2	2	11	LF-11	P1062
6	9	1	2	9	HF-9	P1014	38	2	4	8	G-8	P1071	22	2	2	7	LF-7		47	2	6	10	H-2	P1051
9	4	1	2	4	HF-4	P1036	53	3	2	8	H-8	P1016	18	2	2	3	LF-3	P1010	62	1	4	3	D3H	
10	14	1	2	14	A-5	1002	44	2	4	15	A-4	995	23	2	2	8	LF-8	P1059	63	1	4	4	D4H	
11	5	1	2	5	HF-5	P1029	52	3	2	7	H-7	P1029	19	2	2	4	LF-4	P1001	27	2	2	12	LF-12	P1050
12	29	2	2	14	A-7	966	50	3	2	5	H-5	P1046	46	2	6	9	H-1	P1075	48	2	6	11	H-3	P1078
13	6	1	2	6	HF-6	P1019	56	3	2	11	A-9	997	20	2	2	5	LF-5	P1043	28	2	2	13	LF-13	P1065
14					TC (CAL)						TC (CAL)					TC (CAL)								

NOTES: 1. During Electrical calibrations, CAL signal is applied to tracks indicated as TC(CAL). TC (Transmitted composite) is applied during data runs.

PREPARED BY: R. Newman  
DATE: 25 June 1966

## PURVIS II RECORDING COMBINATION 4 REV O

(REPLACES PURVIS II RECORDING COMBINATION REV )

S.M. included

RECODER NO. 1	RECODER NO. 2				RECODER NO. 3				RECODER NO. 4			
	TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION			
SCA NO.	STA. NO.	CONN. NO.	SERIAL NO.	SCA NO.	STA. NO.	CONN. NO.	SERIAL NO.	SCA NO.	STA. NO.	CONN. NO.	SERIAL NO.	
-												
2												
3												
4												
5												
6												
9												
10												
11												
12												
13												
14												

PURVIS II RECORDING COMBINATION 5 REV 0

(REPLACES PURVIS II RECORDING COMBINATION REV )

EFFECTIVE DATE

No ships motion

TRACK NO.	RECODER NO. 1				RECODER NO. 2				RECODER NO. 3 Basic				RECODER NO. 4			
	TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION			
SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.
1								60	D1-H			75				D1A
2								64	D5-H			79				DSA
3								9	HF-9			1				HF-1
4								10	HF-10			12				HF-12
5								35	G-5			36				G-6
6								33	G-3			34				G-4
7								23	LF8			55				H-10
8								16	LF1			51				H-6
9								19	LF4			49				H-4
10								21	LF6			52				H-7
11								53	H8							TC
12								62	D3H			77				D3-A
13																
14																

## PURVIS II RECORDING COMBINATION A11 REV 0

(REPLACES PURVIS II RECORDING COMBINATION REV 0)

EFFECTIVE DATE \_\_\_\_\_

RECODER NO. 4	RECODER NO. 2			RECODER NO. 3			RECODER NO. 4		
	TRANSDUCER DESCRIPTION			TRANSDUCER DESCRIPTION			TRANSDUCER DESCRIPTION		
	SCA NO.	STA. NO.	CONN. NO.	SCA NO.	STA. NO.	CONN. NO.	SCA NO.	STA. NO.	CONN. NO.
1 Sway		SML	UV13						
2 Surge		SM2	UV14						
3 Heave		SM3	UV15						
4 Flow Flag A		SM4	UV16						
5 Bow Probe		SM5	UV17						
6 Sea State		SM7	UV19						
9 Pitch		SM8	UV20						
10 Roll		SM15	WX19						
11 Yaw		SM16	WX20						
12 Flow Flag B		SM9	WX13						
13 Flow Flag C		SM10	WX14						
14 Flow Flag D		SM11	WX15						

PREPARED BY: M. Casciolo  
DATE: 28 June 1966

## PURVIS II RECORDING COMBINATION 1 REV 1

(REPLACES PURVIS II RECORDING COMBINATION 1 REV 0)

TRACK NO.	RECORDER NO. 1			RECORDER NO. 2			RECORDER NO. 3			RECORDER NO. 4						
	TRANSDUCER DESCRIPTION			TRANSDUCER DESCRIPTION			TRANSDUCER DESCRIPTION			TRANSDUCER DESCRIPTION						
SCA NO	STA NO.	CONN. NO.	ELEMENT NO.	SERIAL NO.	SCA NO	STA NO.	CONN. NO.	ELEMENT NO.	SERIAL NO.	SCA NO	STA NO.	CONN. NO.	ELEMENT NO.	SERIAL NO.		
1	1	2	1	HF-1	P1007	10	1	2	10	HF-10	P1060	60	1	4	1	DIH
2	7	1	2	HF-7	P1030	35	2	4	5	G-5	P1020	61	1	4	2	D2H
3	2	1	2	HF-2	P1011	11	1	2	11	HF-11	P1031	62	1	4	3	D3H
4	6	1	2	HF-8	P1002	43	2	4	13	A-1	999	63	1	4	4	D4H
5	3	1	2	HF-3	P1076	12	1	2	12	HF-12	P1009	64	1	4	5	D5H
6	9	1	2	HF-9	P1014	38	2	4	8	G-8	P1071	65	1	4	6	D6H
9	4	1	2	HF-4	P1036	28	2	2	13	LF-13	P1065	66	1	4	7	D7H
10	29	2	14	A-7	966	44	2	4	14	A-4	995	67	1	4	8	D8H
11	5	1	2	HF-5	P1027	13	1	2	13	HF-13	P1008	68	1	4	9	D9H
12	16	2	1	LF-1	P1015	50	3	2	5	H-5	P1046	69	1	4	10	D10H
13	6	1	2	HF-6	P1019	24	2	2	9	LF-9	P1068	46	2	6	9	H-1
14	14	1	2	14	A-5	1002	56	3	2	11	A-9	997	23	2	8	LF-8
															P1059	

NOTES: 1. During electrical calibrations, CAL signal is applied to track <sup>PREPARED BY: M. Casciolo</sup> marked with star (\*) from power amplifier. (\* connect 1, 2 to CAL amp out)

2. CAL signal to DTMB channels are patched via Q-20 to J-161 on MAC panel to CAL T's on DTMB Amps.

3. Overside CAL signal derived from 1 ohm resistor in T<sub>1</sub> circuit.

DATE: 26 June 1966

4. Records overside cal on runs 9-18

## PURVIS

## II RECORDING COMBINATION 2 REV 1

(REPLACES PURVIS II RECORDING COMBINATION 2 REV 0)

EFFECTIVE DATE

REV 0

RECORDED NO.	RECORDED NO. 1				RECORDED NO. 2				RECORDED NO. 3				RECORDED NO. 4					
	TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION					
TRACK NO.	CABLE STA. NO.	CONN. STA. NO.	ELEMENT NO.	STA. NO.	STA. NO.	CONN. STA. NO.	ELEMENT NO.	STA. NO.	STA. NO.	CONN. STA. NO.	ELEMENT NO.	STA. NO.	STA. NO.	CONN. STA. NO.	ELEMENT NO.	STA. NO.		
1	21 2 2 6	LF-6	P1063	10 1	2 10	HF-10	P1060	31	2 4	1	G-1	P1095	43	2 4	13	A-1	999	
2	20 2 2 5	LF-5	P1043	64	1 4	5	D5H	32	2 4	2	G-2	P1073	60	1 4	1	D1H		
3	2 1 2 2	HF-2	P1011	24	2 2	9	LF-9	P1068	33	2 4	3	G-3	P1021	61	1 4	2	D2H	
4	19 2 2 4	LF-4	P1001	13	1 2	13	HF-13	P1008	35	2 4	5	G-5	P1020	47	2 6	10	H-2	P1051
5	3 1 2 3	HF-3	P1076	25	2 2	10	LF-10	P1012	38	2 4	8	G-8	P1071	48	2 6	11	H-3	P1078
6	18 2 2 3	LF-3	P1010	65	1 4	6	D6H		34	2 4	4	G-4	P1098	49	2 6	12	H-4	P1057
9	22 2 2 7	LF-7	P1029	26	2 2	11	LF-11	P1062	36	2 4	6	G-6	P1042	62*	1 4	3	(CAL) D3H	
10	17 2 2 2	LF-2	P1034	9	1 2	9	HF-9	P1014	37	2 4	7	G-7	P1045	63	1 4	4	D4H	
11	23 2 2 8	LF-8	P1059	27	2 2	12	LF-12	P1050	4*	2 4	14	(CAL) A-4	995	39	2 4	9	G-9	P1079
12	16 2 2 1	LF-1	P1015	46	2 6	9	H-1	P1075	40	2 4	10	G-10	P1052	45	2 4	15	A-11	992
13	29 2 2 14	A-7	966	28	2 2	13	LF-13	P1065	41	2 4	11	A-2	994	50	3 2	5	H-5	P1046
14	* 14 1 2 14	(CAL) A-5	1002	*			(CAL) O.S. CAL		42	2 4	12	A-3	993	56	3 2	11	A-9	997

NOTES: Same as combo 1, rev. 1,  
 "CAL" indicates calibration signal is applied in elec. calib. panels

C-9

PREPARED BY: M.E. Casciolo  
 DATE: 27 June 1966

## PURVIS II RECORDING COMBINATION 3 REV 1

(REPLACES PURVIS II RECORDING COMBINATION 3 REV 0)

EFFECTIVE DATE

TRACK NO.	RECORDER NO. 1				RECORDER NO. 2				RECORDER NO. 3				RECORDER NO. 4				
	TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				
SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	
1	1	2	1	HF-1	P1007	51	3	2	6	H-6	P1061	16	2	2	1	LF-1	
2	7	1	2	HF-7	P1030	35	2	4	5	G-5	P1020	21	2	2	6	LF-6	
3	2	1	2	HF-2	P1011	55	3	2	10	H-10	P1049	17	2	2	2	LF-2	
4	8	1	2	HF-8	P1002	30	2	2	15	A-8	1003	64	1	4	5	D5H	
5	3	1	2	HF-3	P1076	54	3	2	9	H-9	P1009	65	1	4	6	D6H	
6	9	1	2	HF-9	P1014	38	2	4	8	G-8	P1071	22	2	2	7	LF-7	
7	4	1	2	HF-4	P1036	53	3	2	8	H-8	P1016	18	2	2	3	LF-3	
8	15	1	15	A-6	1001					O.S. CAL		23	2	2	8	LF-8	
9	5	1	2	5	HF-5	P1027	52	3	2	7	H-7	P1029	19	2	2	4	LF-4
10	29	2	2	A-7	966	50	3	2	5	H-5	P1046	46	2	6	9	H-1	
11	6	1	2	6	HF-6	P1019	56	3	2	11	A-9	997	20	2	2	5	LF-5
12				TC (CAL)						TC (CAL)					TC (CAL)	TC* (CAL)	

NOTES: During elec. Calib., CAL signal is applied to tracks marked "TC (CAL)". TC(transmitted composite) is applied during data runs.  
 \* gets overside cal signal during overside c/s

Rec 2 track 1c gets data from monitor patch 3.

PREPARED BY M.E. Casciolo  
 DATE, 27 June 1966

FORM NO. CP-3

CREATIVE 2022

PURVIS II RECORDING COMBINATION 4 REV 1

160 REV 0 1 RECORDING COMBINATION II BIAS LEVELS PER ACES

RECODER NO. 1	RECODER NO. 2	RECODER NO. 3	RECODER NO. 4
TRANSDUCER DESCRIPTION			
TRACK NO.	SCA NO.	SCA NO.	SCA NO.
	SCA NO.	SCA NO.	SCA NO.
	CONN. NO.	CONN. NO.	CONN. NO.
	ELEM. NO.	ELEM. NO.	ELEM. NO.
	SERIAL NO.	SERIAL NO.	SERIAL NO.
1			
2			
3			
4			
5			
6			
9			
10			
11			
12			
13			
14			

PREPARED BY: M. Gascio 1010  
DATE: 21 July 1966

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**APPENDIX D**

**SHIPBOARD DATA FORMS**

CP SONAR PROGRAM-RUN DESCRIPTION SHEET

DATE \_\_\_\_\_ FORM NO. CP1 SERIAL NO. \_\_\_\_\_ RUN NO. \_\_\_\_\_

- BOW WAVE HOSE  
 EXTERNAL CAMERA  
 FISH EYE CAMERA  
 FULL TURN

- TRANSMISSION RUN  
 PASSIVE RUN  
 OVERTSIDE CALIBRATION  
 ELECTRICAL CALIBRATION

 OTHER

START TIME \_\_\_\_\_ INDEX TIME \_\_\_\_\_ STOP TIME \_\_\_\_\_

SHIPS SPEED \_\_\_\_\_ KNOTS MASKER COMBINATION \_\_\_\_\_

RECORD COMB \_\_\_\_\_ REV. \_\_\_\_\_ SCFM

HEADING WRT SEA \_\_\_\_\_ RUDDER ANGLE \_\_\_\_\_

PORT ENGINE RPM \_\_\_\_\_ RECORDING FLOW FLAGS A B C D

STBD ENGINE RPM \_\_\_\_\_ TRANSMIT 1 FREQUENCY \_\_\_\_\_ kHz

WIND VELOCITY REL. \_\_\_\_\_ KNOTS TRANSMIT 2 FREQUENCY \_\_\_\_\_ kHz

WIND DIRECTION REL. \_\_\_\_\_ TRANSMIT 3 FREQUENCY \_\_\_\_\_ kHz

WATER TEMPERATURE \_\_\_\_\_ TRANSMIT 4 FREQUENCY \_\_\_\_\_ kHz

SEA STATE \_\_\_\_\_ PROBE EXTENSION \_\_\_\_\_ FEET

SHIPS COURSE \_\_\_\_\_ PROBE VELOCITY \_\_\_\_\_ KNOTS

COMMENTS \_\_\_\_\_

RECORDER NO.	1	2	3	4	5
TAPE REEL NO.					
COUNTER START					
COUNTER STOP					

**PURVIS II RECORDING COMBINATION REV**

(REPLACES PURVIS II RECORDING COMBINATION REV )

RECODER NO. 1	RECODER NO. 2				RECODER NO. 3				RECODER NO. 4			
	TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION				TRANSDUCER DESCRIPTION			
SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.
SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.	STA. NO.	CONN. NO.	ELEMENT NO.	SCA NO.
	-	2	3	4	5	6	7	8	9	10	=	12
												13
												14

B026-47011/47013

PREPARED BY: \_\_\_\_\_  
DATE: \_\_\_\_\_

B026-47011/47013

## C/P SONAR PROGRAM

**FORM NO.** CP-4

**MAGNETIC TAPE DESCRIPTION SHEET**

TAPE REEL NO. \_\_\_\_\_

DATE AT START OF RECORDING \_\_\_\_\_

**DATE AT END OF RECORDING** \_\_\_\_\_

**COMMENTS:**

D-4

B026-47011/47013

## C/P SONAR PROGRAM—GAIN SETTING SHEET

DATE \_\_\_\_\_ FORM NO. CP2 SERIAL NO. \_\_\_\_\_ RUN NO. \_\_\_\_\_

- BOW WAVE HOSE  
 EXTERNAL CAMERA  
 FISHEYE CAMERA  
 FULL TURN

- TRANSMISSION RUN  
 PASSIVE RUN  
 OVERSIDE CALIBRATION  
 ELECTRICAL CALIBRATION

 OTHER

## RECORD COMBO I

SCA NO.	GAIN SETTING DB	FREQ. FILTER SETTING Hz	SCA NO.	GAIN SETTING DB	FREQ. FILTER SETTING Hz	SCA NO.	GAIN SETTING DB	FREQ. FILTER SETTING Hz	SHIP MOTION			
									X AC T	SIGNAL NAME	GAIN SETTING	L.P. FILTER Hz
1			29			57			1	SWAY		
2			30			58			2	SURGE		
3			31			59			3	HEAVE		
4			32			60			4	FF A		
5			33			61			5	BOW P		
6			34			62			6	SEA S		
7			35			63			9	PITCH		
8			36			64			10	ROLL		
9			37			65			11	YAW		
10			38			66			12	FF B		
11			39			67			13	FF C		
12			40			68			14	FF D		
13			41			69						
14			42			70						
15			43			71						
16			44			72						
17			45			73						
18			46			74						
19			47			75						
20			48			76						
21			49			77						
22			50			78						
23			51			79						
24			52			80						
25			53			81						
26			54			82						
27			55			83						
28			56			84						

RECORDED BY \_\_\_\_\_

CHECKED BY \_\_\_\_\_

B026-47011/47013

## C/P SONAR PROGRAM—GAIN SETTING SHEET

DATE \_\_\_\_\_ FORM NO. CP2 SERIAL NO. \_\_\_\_\_ RUN NO. \_\_\_\_\_

BOW WAVE HOSE  
 EXTERNAL CAMERA  
 FISHEYE CAMERA  
 FULL TURN

TRANSMISSION RUN  
 PASSIVE RUN  
 OVERSIDE CALIBRATION  
 ELECTRICAL CALIBRATION

 OTHER

## RECORDING COMBO 2

SCA NO.	GAIN SETTING DB	FREQ. FILTER SETTING Hz	SCA NO.	GAIN SETTING DB	FREQ. FILTER SETTING Hz	SCA NO.	GAIN SETTING DB	FREQ. FILTER SETTING Hz	SHIP MOTION			
									TRACK	SIGNAL NAME	GAIN SETTING	L.P. FILTER Hz
1			29			57			1	SWAY		
H 2			30			58			2	SURGE		
H 3			31 GI			59			3	HEAVE		
4			32			60			4	FF A		
5			33			61			5	BOW P		
6			34			62			6	SEA S		
7			35			63			9	PITCH		
8			36			64			10	ROLL		
9			37			65			11	YAW		
10			38			66			12	FF B		
11			39			67			13	FF C		
12			40 GIO			68			14	FF D		
13			41 A			69						
14			42 A			70						
15			43 A			71						
16			44 A			72						
17			45 A			73						
18			46 H			74						
19			47 H			75						
20			48 H			76						
21			49 H			77						
22			50 H			78						
23			51			79						
24			52			80						
25			53			81						
26			54			82						
27			55			83						
28			56			84						

RECORDED BY \_\_\_\_\_

CHECKED BY \_\_\_\_\_

B026-47011/47013

## C/P SONAR PROGRAM—GAIN SETTING SHEET

DATE \_\_\_\_\_ FORM NO. CP2 SERIAL NO. \_\_\_\_\_ RUN NO. \_\_\_\_\_

- BOW WAVE HOSE  
 EXTERNAL CAMERA  
 FISHEYE CAMERA  
 FULL TURN

- TRANSMISSION RUN  
 PASSIVE RUN  
 OVERSIDE CALIBRATION  
 ELECTRICAL CALIBRATION

 OTHER

## RECORDING COMBO 3

SCA NO.	GAIN SETTING DB	FREQ. FILTER SETTING Hz	SCA NO.	GAIN SETTING DB	FREQ. FILTER SETTING Hz	SCA NO.	GAIN SETTING DB	FREQ. FILTER SETTING Hz	SHIP MOTION			
									TRACK	SIGNAL NAME	GAIN SETTING	L.P. FILTER Hz
1			29				57		1	SWAY		
2			30				58		2	SURGE		
3			31				59		3	HEAVE		
4			32				60		4	FF A		
5			33				61		5	BOW P		
6			34				62		6	SEA S		
7			35				63		9	PITCH		
8			36				64		10	ROLL		
9			37				65		11	YAW		
10			38				66		12	FF B		
11			39				67		13	FF C		
12			40				68		14	FF D		
13			41				69					
14			42				70					
15			43				71					
16			44				72					
17			45				73					
18			46				74					
19			47				75					
20			48				76					
21			49				77					
22			50				78					
23			51				79					
24			52				80					
25			53				81					
26			54				82					
27			55				83					
28			56				84					

RECORDED BY \_\_\_\_\_

CHECKED BY \_\_\_\_\_

APPENDIX E  
DATA PROCESSING

The digital data processing for the PURVIS test consists of both auto and cross correlations of the output from sonar hydrophones, spectral density and cross spectral density, including both the magnitude and phase, and both the amplitude probability distribution, and the cumulative probability distribution. The spectral density is obtained by solving for the Fourier transform of the correlation function. A general block diagram of the data processing is shown in Figure E-1a and E-1b. The digital magnetic tapes (two used for the cross correlation or cross power spectrum) are applied to the input of the digital computer. The first operation is a cross or auto correlation. In the case where one tape contains ship's motion data, the average power from the sonar hydrophone is cross correlated with the ship's motion to determine if there is any effect of ship's motion on average signal power.

The auto correlation is a symmetrical function and thus the auto correlation is presented for only positive displacements. Cross correlation is non-symmetrical and there are both the positive and negative displacements for cross correlation. In the system presented, filtering is performed during the analog formatting process. There is no digital filtering performed in this system. The spectral density as indicated before is obtained by taking the Fourier transform of the correlation function. Frequency

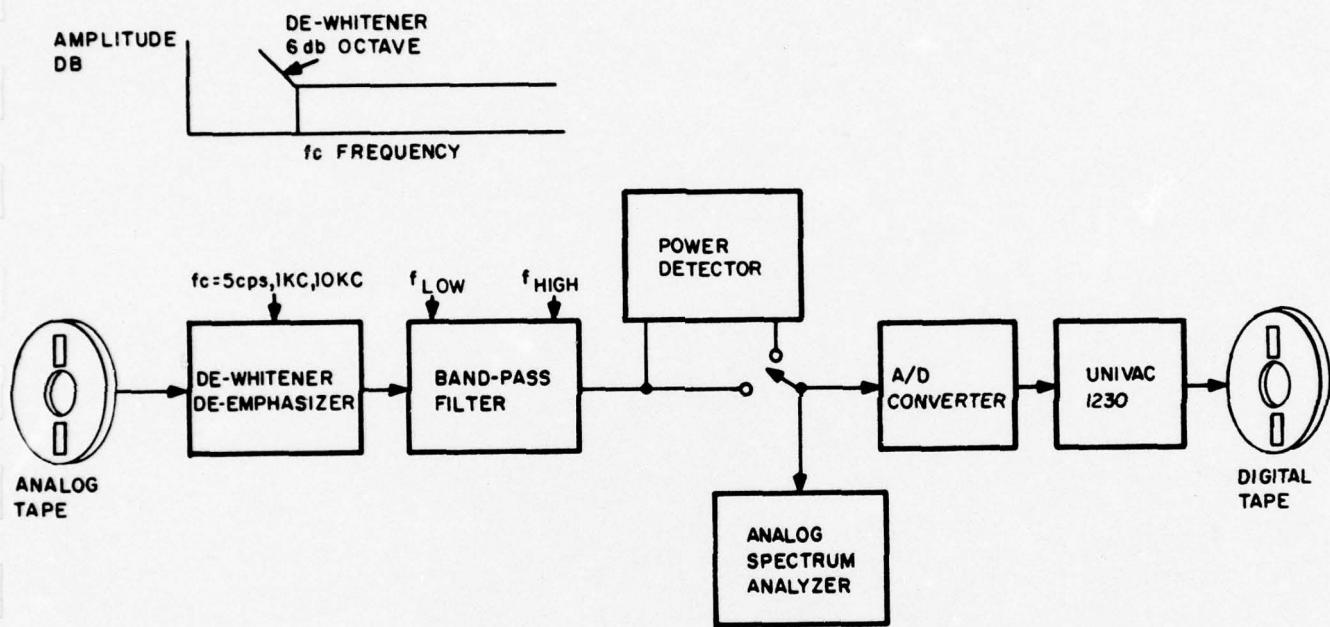


FIGURE E-1a. BLOCK DIAGRAM: ANALOG DATA FORMATTING AND PROCESSING

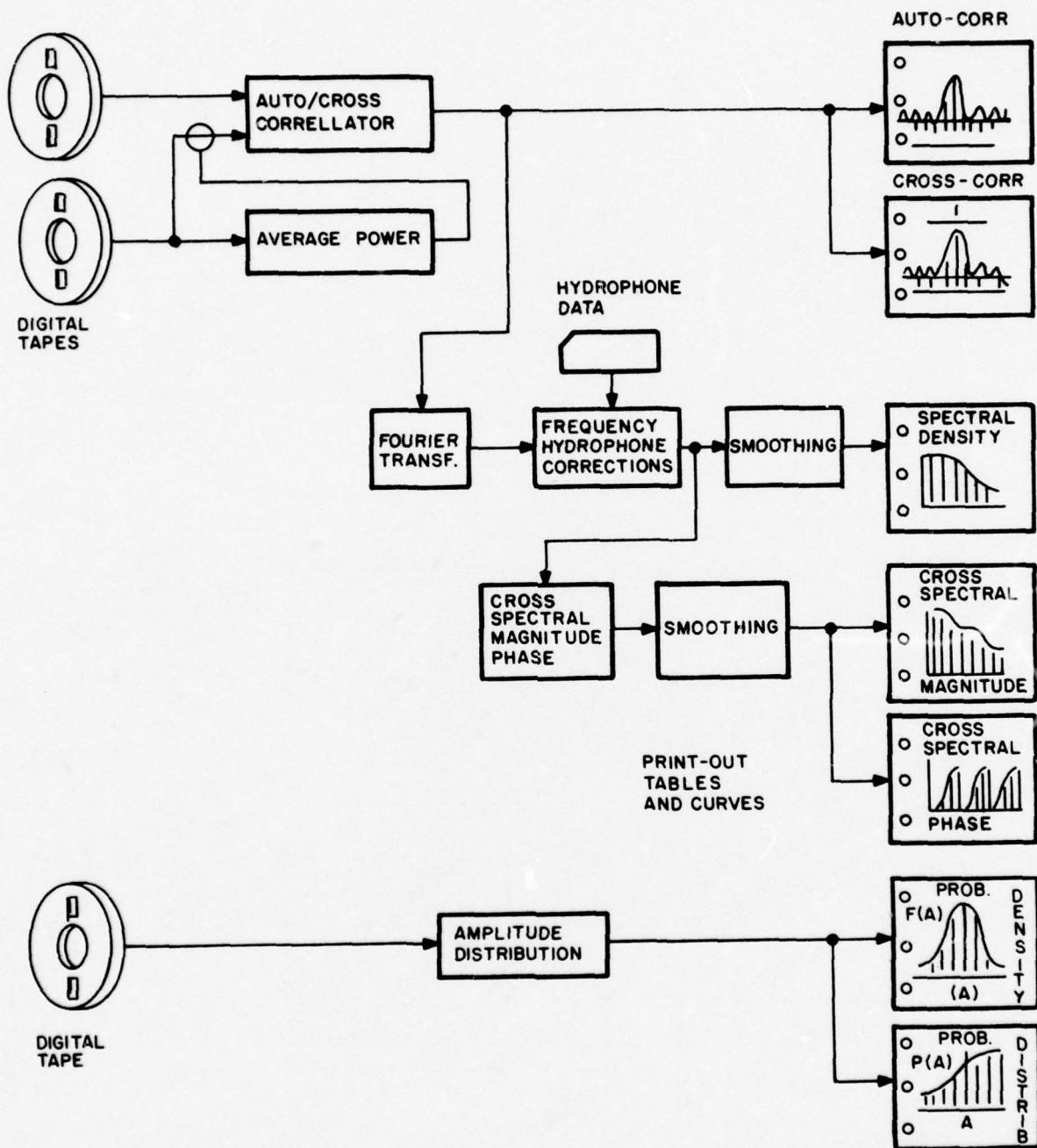


FIGURE E-1b. REPRESENTATION OF DATA PROCESSING

correction for "preemphasis" or "whitening" of the signal is also performed in the formatting operation and corrections for hydrophone sensitivity are performed in the digital computer. The outputs are presented both in a tabular fashion and by special plotting routines. Curves are available via an automatic plotter. The probability density and the cumulative probability distribution are also calculated by the program.

The equations that are used for the processing have been separated into three categories: (1) correlation, (2) spectral density, and (3) probability density. The computer equations are indicated in the following pages.

The processing of acoustic data is done in five stages as illustrated in Figure E-2.

(1) PREPARE CORRECTION DATA

Hydrophone sensitivity data, skew correction data, and information which cross-references hydrophone vs. tape recorder track is encoded on cards and tables are generated on the program tape by the utility program.

(2) FORMAT

The analog data is digitized and stored on magnetic tape by the TRG formatting equipment operating on-line with the Univac 1230 Computer.

The pertinent data generated in step 1 and identification data entered by card are assembled into a header record which precedes the data on the formatted data tape.

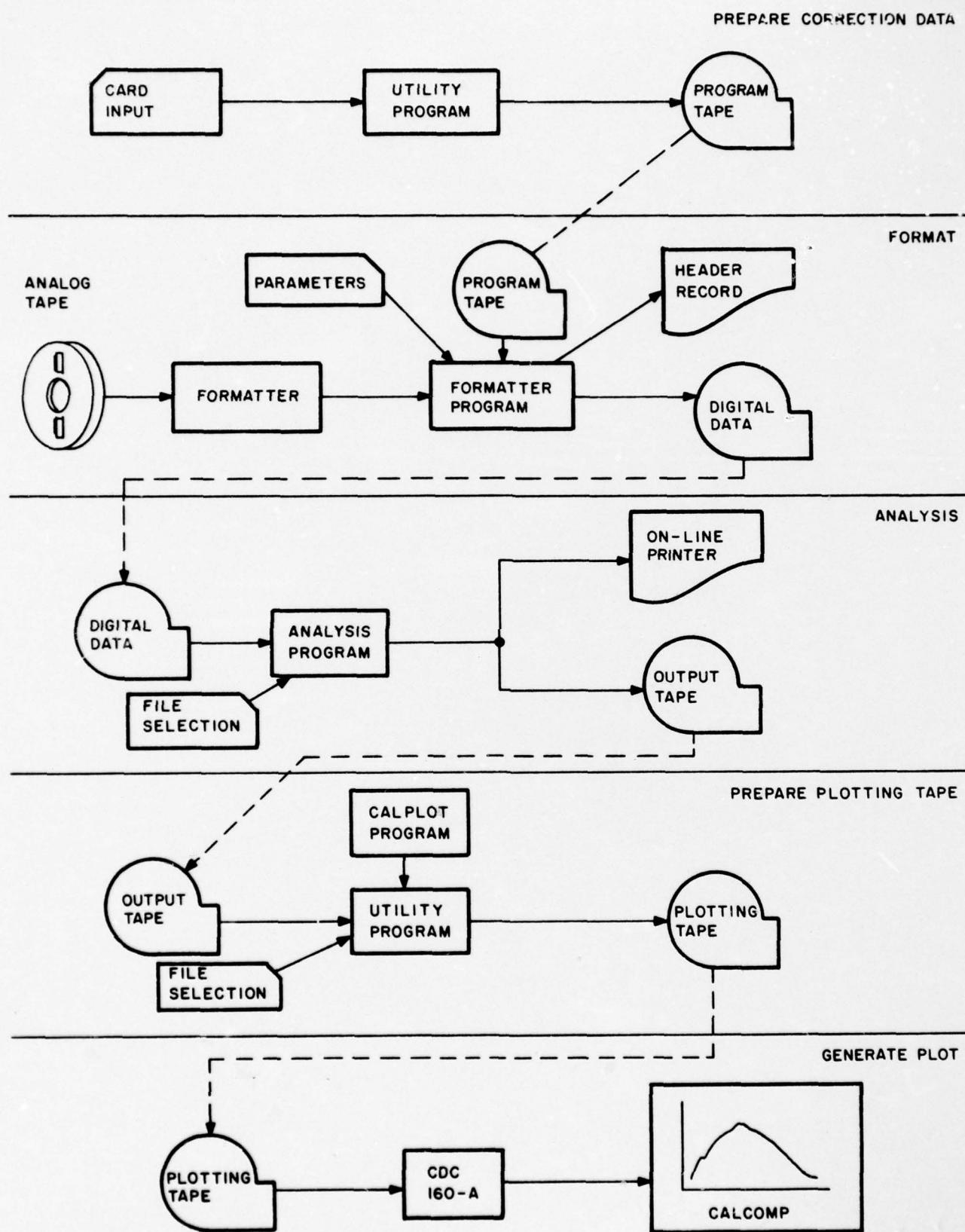


FIGURE E-2. PROCESSING OF ACOUSTIC DATA

A portion of the header record is outputted on the on-line printer and serves as a log for the formatting operation.

### (3) ANALYSIS

The formatted data is used as input to the analysis program. Data selection is accomplished by card input. Results of the analysis are outputted on magnetic tape and on the on-line printer.

### (4) PREPARE PLOTTING TAPE

The output tape generated by the analysis program is used as input to a program which generates a tape containing data for plotting. The data to be plotted is selected by card input.

The utility program contains the routine used for preparing the plotting tape; and, in turn, uses the CALPLOT routine which is in the Mongoose monitor system.

### (5) GENERATE PLOT

The output of step 4 is used as input to the CDC 160-A computer, which generates a  $\frac{1}{100}$  inch resolution plot of the analysis output.

## CORRELATION

The cross-covariance of two stationary processes  $x(t)$  and  $y(t)$  may be defined as

$$c_{xy}(\tau) = E \left[ (x(t) - \mu_x) (y^*(t+\tau) - \mu_y^*) \right]$$

where  $E$  denoted expected value and  $*$  denotes conjugate  $\mu_x$  and  $\mu_y$  are the expected values of  $x$  and  $y$  respectively.

This is equivalent to

$$c_{xy}(\tau) = \lim_{T \rightarrow \infty} \frac{1}{2T} \int_{-T}^T [x(t) - \mu_x][y^*(t+\tau) - \mu_y^*] dt.$$

We will approximate the above integral by a finite sum and restrict  $x$  and  $y$  to real functions for our application.

Then

$$c_{xy}(\tau) = c_{xy}(p \Delta t) \approx \frac{1}{(n-p) \Delta t} \sum_{k=1}^{n-p} (x_k - \mu_x)(y_{k+p} - \mu_y) \Delta t$$

where  $\tau = p \Delta t$

and

$$\overline{(2)y_p} = \frac{1}{n-p} \sum_{k=1}^{n-p} y_{k+p} \text{ respectively,} \quad (\text{Eq. 2})$$

and hence,

$$c_{xy}(\tau) \approx b_{xy}(p \Delta t) = \frac{1}{(n-p)} \sum_{k=1}^{n-p} (x_k - \overline{(1)x_p})(y_{k+p} - \overline{(2)y_p}) \quad (\text{Eq. 3})$$

Figure E-3 illustrates the technique used. The x and y records are sampled at n points providing sample sets  $(x_1, x_2, \dots, x_p, \dots, x_n)$  and  $(y_1, y_2, \dots, y_p, \dots, y_n)$  respectively and the above calculation is performed. Note that total time interval effectively used decreases as p increases; therefore, it is necessary that n be much greater than p in order to maintain accuracy. A ratio of 10 or 20 to one is adequate.

We now wish to approximate the normalized cross-covariance defined by

$$R_{xy}(\tau) = \frac{C_{xy}(\tau)}{\sqrt{\sigma_x^2 \sigma_y^2}} .$$

The variance of a stationary process  $X(t)$  is given by

$$\sigma_x^2 = E[(X(t) - \bar{X})^2] = C_{xx}(0) .$$

Rather than estimating  $\sigma_x^2$  and  $\sigma_y^2$  by using the total x or y record, we use only the portion of the record which is used in the covariance calculation. Hence, the estimate for  $\sigma_x^2$  and  $\sigma_y^2$  will be a function of p. The estimates are made by means of the expressions,

$$\sigma_x^2 \approx \{(1) s_{x_p}\}^2 = \frac{1}{n-p} \sum_{k=1}^{n-p} (x_k - \bar{x}_p)^2 \quad \text{and}$$

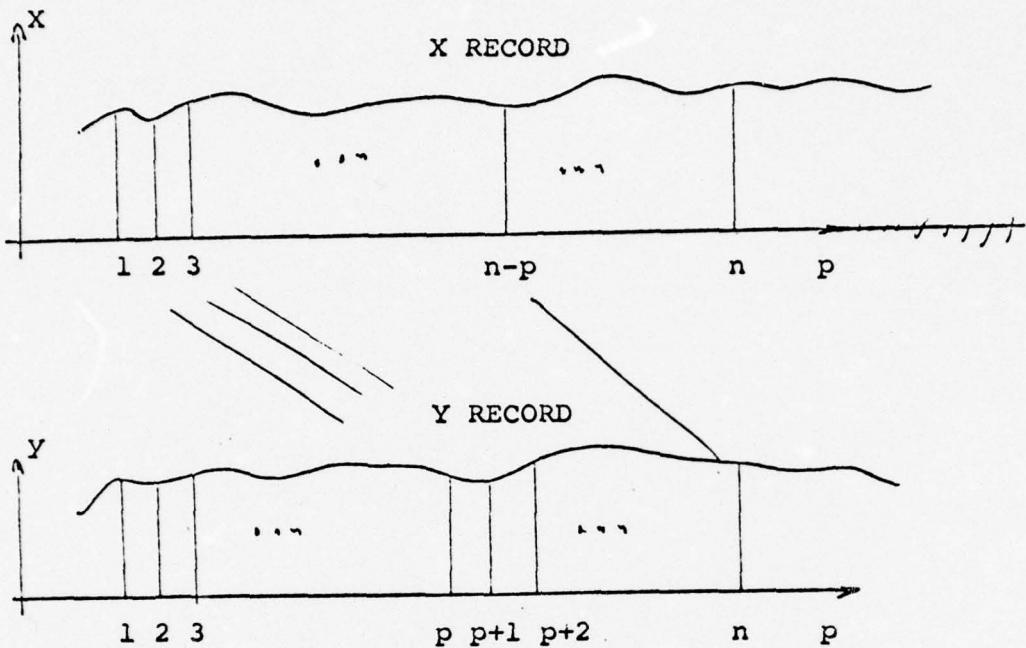


FIGURE E-3

The mean values  $\hat{M}_x = \lim_{T \rightarrow \infty} \frac{1}{2T} \int_{-T}^T x(t) dt$  and  
 $\hat{M}_y = \lim_{T \rightarrow \infty} \frac{1}{2T} \int_{-T}^T y(t) dt$  are replaced by

$$\overline{(1)} x_p = \frac{1}{n-p} \sum_{k=1}^{n-p} x_k \quad (\text{Eq. 1})$$

$$\bar{C}_y^2 \approx \left( (2) s_{y_p} \right)^2 = \frac{1}{n-p} \sum_{k=1}^{n-p} (y_{k+p} - \bar{(2)y_p})^2$$

Now the estimate for  $R_{xy}(\tau)$  becomes

$$R_{xy}(\tau) = R_{xy}(p\Delta t) \approx \frac{B_{xy}(p\Delta t)}{\left( (1) s_{x_p} \right) \left( (2) s_{y_p} \right)}$$

For any two processes  $x(t)$  and  $y(t)$ ,  $R_{xy}(\tau) = R_{yx}(-\tau)$ ;  
hence, we may find  $R_{xy}(\tau)$  for  $\tau < 0$  by calculating  $R_{yx}(|\tau|)$

$$R_{xy}(\tau) = R_{yx}(|\tau|) \text{ for } \tau < 0.$$

Similarly, the autocovariance and normalized autocovariance of a process  $x(t)$  may be calculated using the same formula, where  $(2)y_p$  is replaced by  $(2)x_p$ . Since  $C_{xx}(\tau) = C_{xx}(-\tau)$  for a real process, we need only calculate  $R_{xy}(p\Delta t)$  for  $p \geq 0$ .

SPECTRAL DENSITY

The cross-spectral density may be defined as the Fourier transform of the cross-covariance function

$$\phi_{xy}(\omega) = \int_{-\infty}^{\infty} c_{xy}(\tau) e^{-j\omega\tau} d\tau.$$

By simple substitution, this expression becomes

$$\begin{aligned} \phi_{xy}(\omega) &= \int_{-\infty}^{\infty} [ (c_{xy}(\tau))_{\text{REAL}} \cos \omega\tau + (c_{xy}(\tau))_{\text{IMAG}} \sin \omega\tau ] d\tau \\ &- j \int_{-\infty}^{\infty} [ (c_{xy}(\tau))_{\text{REAL}} \sin \omega\tau - (c_{xy}(\tau))_{\text{IMAG}} \cos \omega\tau ] d\tau \end{aligned}$$

For our application,  $c_{xy}(\tau)$  is real, therefore,

$$\phi_{xy}(\omega) = \int_{-\infty}^{\infty} c_{xy}(\tau) \cos \omega\tau d\tau - j \int_{-\infty}^{\infty} c_{xy}(\tau) \sin \omega\tau d\tau. \quad (\text{Eq. 4})$$

$$= a_{xy}(\omega) - j b_{xy}(\omega)$$

$$\text{We now define } a_{xy}(\tau) = \frac{1}{2}(c_{xy}(\tau) + c_{yx}(\tau))$$

$$\text{and } b_{xy}(\tau) = \frac{1}{2}(c_{xy}(\tau) - c_{yx}(\tau)).$$

Then  $c_{xy}(\tau) = a_{xy}(\tau) + b_{xy}(\tau)$  and, therefore,  $a_{xy} + b_{xy}$  may be substituted for  $c_{xy}$  in equation 4. Since  $c_{xy}(-\tau) = c_{yx}(\tau)$ ,  $a_{xy}(\tau)$  is even and  $b_{xy}(\tau)$  is odd; therefore, equation

reduces to

$$\phi_{xy}(\omega) = 2 \int_0^\infty \alpha_{xy}(\tau) \cos \omega \tau d\tau - j2 \int_0^\infty \beta_{xy}(\tau) \sin \omega \tau d\tau.$$

Again, we approximate the integrals by finite sums as illustrated in Figure E-4, and hence,

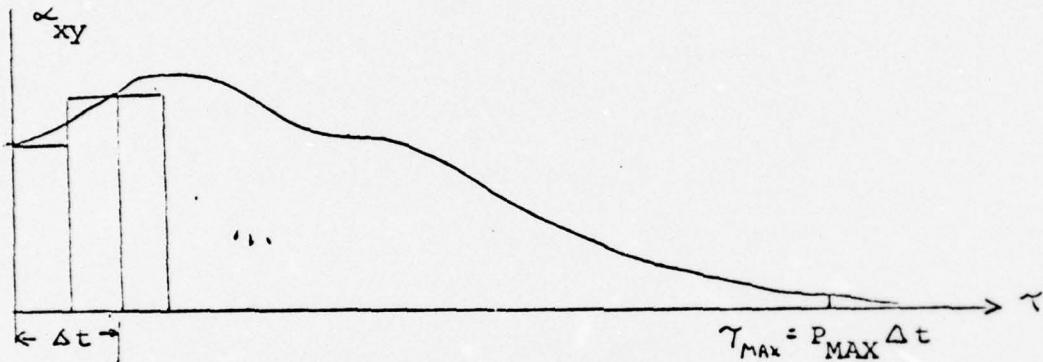


FIGURE E-4.

$$\begin{aligned} a_{xy}(\omega) &= a_{xy}(q \Delta \omega) = 2 \left[ \frac{\Delta t}{2} \alpha_{xy}(0) + \sum_{p=1}^{P_{MAX}-1} \alpha_{xy}(p \Delta t) \cos(\omega p \Delta t) \Delta t \right. \\ &\quad \left. + \frac{\Delta t}{2} \alpha_{xy}(P_{MAX} \Delta t) \cos(\omega P_{MAX} \Delta t) \right] \text{ where } \omega = q \Delta \omega. \quad (\text{Eq. 5}) \end{aligned}$$

The frequency resolution in hertz denoted by  $\Delta f$  is given by  $\Delta f = \frac{1}{2T_{MAX}}$ .

$$\text{Hence, } \omega_{\Delta t} = q \Delta \omega_{\Delta t} = q \left( 2 \pi \frac{1}{2p_{\max} \Delta t} \right) \Delta t = \frac{q \pi}{p_{\max}}$$

Thus, equation 5 reduces to

$$a_{xy}(q \Delta \omega) = \Delta t \left[ a_{xy}(0) + 2 \sum_{p=1}^{p_{\max}-1} a_{xy}(p \Delta t) \cos \left( \frac{pq\pi}{p_{\max}} \right) + a_{xy}(p_{\max} \Delta t) (-1)^q \right].$$

Similarly, for  $b_{xy}(\omega)$

$$b_{xy}(\omega) = b_{xy}(q \Delta \omega) = \Delta t \left[ 2 \sum_{p=1}^{p_{\max}-1} b_{xy}(p \Delta t) \sin \left( \frac{pq\pi}{p_{\max}} \right) \right].$$

The estimates  $a_{xy}(q \Delta \omega)$  and  $b_{xy}(q \Delta \omega)$  are smoothed using hanning weights.

$$\hat{a}_{xy}(0) = \frac{1}{2} [a_{xy}(0) + a_{xy}(\Delta \omega)]$$

$$\hat{a}_{xy}(q \Delta \omega) = \frac{1}{4} a_{xy}((q-1) \Delta \omega) + \frac{1}{2} a_{xy}(q \Delta \omega) + \frac{1}{4} a_{xy}((q+1) \Delta \omega)$$

for  $0 < q < q_{\max}$ ,  $q \neq 1$

$$\hat{a}_{xy}(q_{\max} \Delta \omega) = \frac{1}{2} [a_{xy}((q_{\max}-1) \Delta \omega) + a_{xy}(q_{\max} \Delta \omega)]$$

The  $\hat{b}_{xy}(q \Delta \omega)$  are found similarly.

The spectral density is a special case of the above.

To find  $\phi_{xx}(\omega)$ ,  $C_{xy}(\tau)$  is replaced by  $C_{xx}(\tau)$ . Thus,  $B_{xy}(\tau) = 0$ , and, hence  $\phi_{xx}(\omega) \cong a_{xx}(\omega)$ . The  $a_{xx}(q\Delta\omega)$  values are determined as in the cross-spectrum case.

The cross-spectral estimates are normalized with respect to the spectral densities of the individual signals

$$G_{xy}(\omega) = \frac{\phi_{xy}(\omega)}{\sqrt{\phi_{xx}(\omega)\phi_{yy}(\omega)}} .$$

The real and imaginary parts of the normalized cross-spectral estimates are denoted by  $A_{xy}(q\Delta\omega)$  and  $B_{xy}(q\Delta\omega)$  respectively, and are given by

$$A_{xy}(q\Delta\omega) = \frac{\hat{a}_{xy}(q\Delta\omega)}{\sqrt{\hat{a}_{xx}(q\Delta\omega)\hat{a}_{yy}(q\Delta\omega)}} \text{ called "Cospectrum", and}$$

$$B_{xy}(q\Delta\omega) = \frac{\hat{b}_{xy}(q\Delta\omega)}{\sqrt{\hat{b}_{xx}(q\Delta\omega)\hat{b}_{yy}(q\Delta\omega)}} \text{ called "Quadrature spectrum."}$$

Thus,  $G_{xy}(q\Delta\omega) \cong A(q\Delta\omega) - jB(q\Delta\omega)$  and  $G_{xy}(q\Delta\omega) = \sqrt{A^2(q\Delta\omega) + B^2(q\Delta\omega)}$

$$\angle G_{xy}(q\Delta\omega) \cong \tan^{-1} \left[ \frac{-B_{xy}(q\Delta\omega)}{A_{xy}(q\Delta\omega)} \right] .$$

B026-47011/47013

APPENDIX F

SHIPBOARD INSPECTION REPORTS



ROUTE 110 • MELVILLE, NEW YORK 11746 • 516/531-0600

June 21, 1966

Mr. J. Luistro, Code 589  
Department of the Navy  
David Taylor Model Basin  
Washington, D. C. 20007

Subject: Measurements of Clearances Between TRG Sea Chests  
and Transducers Installed for PURVIS II Tests

Reference: Contract N0bsr 93023

Dear Mr. Luistro:

Enclosed are the measurements taken with a feeler gage  
of the clearances between the rubber face of the transducer  
element and the sea chests.

Very truly yours,

*J. Koestner Jr.*  
J. Koestner

cc: M. Baldwin  
I. Cook  
R. Duerr  
G. Franz  
J. Gilbreath

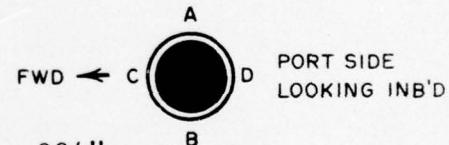
bcc: W. Graham  
W. Landauer  
N. Nesenoff  
R. Newman  
I. Melnick  
A. Raff

### LOW FREQUENCY ARRAY

<u>ELEMENT NO.</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
LF1	.022"	.032"	.037	.027
LF2	.027	.025	.039	.039
LF3	.027	.025	.037	.037
LF4	.010	.010	.027	.026
LF5	.030	.029	.038	.027
LF6	.037	.018	.037	.027
LF7	.037	.037	.035	.037
LF8	.037	.025	.037	.039
LF9	.002	.037	.015	.018
LF10	.025	.027	.036	.018
LF11	.026	.027	.036	.018
LF12	.027	.025	.039	.037
LF13	.022	.032	.036	.026

### HIGH FREQUENCY ARRAY

HF1	.032"	.032"	.028"	.034"
HF2	.032	.035	.035	.040
HF3	.035	.032	.032	.037
HF4	.031	.035	.035	.034
HF5	.038	.031	.029	.027
HF6	.034	.027	.027	.025
HF7	.027	.030	.023	.021
HF8	.035	.017	.021	.019
HF9	.025	.026	.026	.023
HF10	.025	.027	.025	.027
HF11	.025	.027	.015	.012
HF12	.035	.038	.035	.025
HF13	.034	.022	.027	.029



SEA CHEST NO. 2 (GENERAL DYNAMICS)

	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>
G1	.006"	.006"	.006"	.006"
G2	.006	.004	.005	.005
G7	.005	.004	.005	.004
G8	.005	.003	.010	.005
G9	.006	.007	.008	.005
G10	.006	.008	.008	.006

T R I P    R E P O R T

To: Distribution Below

From: Joseph Koestner

Date of Trip: August 1 through August 6, 1966.

Place: Boston Naval Shipyard

Subject: The inspection and removal of all hardware installed  
aboard the U.S.S. Hugh Purvis (DD 709) for the  
Purvis II Tests.

Attendees: J. Luistro, DTMB; R. Duerr, DTMB; J. Koestner, TRG;  
E. Doerrlamm, TRG; M. Casiolo, TRG; H. Katz, TRG;  
R. Steckman, TRG; A. Stora TRG-Boston; R. Giordano,  
TRG-Boston.

A) The hardware removed is as follows:

1. All TRG transducers (46) were removed and disassembled  
for shipping. They were packed two assemblies in a box. Each  
assembly contained a TRG element with its extension, retainer  
and preamplifier. This also included the accelerometer and its  
preamplifier if any. The connector between the element and  
preamplifier was taken off to remove element and put on again  
to facilitate the calibration of transducer. The following  
conditions were found upon removal.

a) There was water up to the first O'ring past the  
rubber face on all transducers except those in number "2" (CD)  
Seachest. This was due to weld distortion of those seachests  
installed by BNS.

b) Due to the water there were considerable salt  
deposits on the brass of the transducer up to the first O'ring.  
The rubber appeared unaffected and in good condition.

c) All transducers were washed with fresh water and  
their rubber faces coated with silicone grease then covered with  
a protective cap for handling.

d) A listing of actual locations of each element, its  
preamplifier and accelerometer preamplifier is attached to this  
report.

Contd..

2. The TRG Seachests (8) in Number 2 (GD)Seachest were removed and are being shipped with the TRG transducers. Extra covers, bolts, barrel nuts and gaskets have been included. All the remaining TRG Seachests will be scrapped.

3. All DTMB FS-13 Hydrophones (10) in the No. 1 (GD)Seachest were removed, tagged and shipped to DTMB as per R. Duerr's instructions. Attached to this report is a listing of the rubber thickness at each Hydrophone.

4. The McIntosh amplifier was removed and will be shipped back to TRG. The remaining amplifiers are DTMB's property and are being shipped as per R. Duerr's instructions.

5. The retractable and fixed struts are being removed by BNS and put into DTMB's Store at BNS to wait later disposition.

6. All Flow Flags with the exception of one were to be scrapped. The remaining one is being shipped to DTMB for analysis.

7. The fisheye cameras and dead light windows are to be shipped to DTMB.

8. The recording center air-conditioner was removed and packed. It will be put in DTMB's store at BNS.

9. The hydrophones (LC-57) in the sonar dome (T-1) and in No. 2 TRG Strut (T-4) were removed. They will be shipped with TRG transducers. Included with them will be the mount used on T-4.

B. An inspection of the hull surfaces disclosed the following conditions:

1. Devcon filler around the TRG Seachests had lifted up forming a scoop that was 1/2 inch wide by 1/4 inch high and 3/8 inches deep. This was next to the element face. In some places it had broken away leaving a 1/16 inch deep hole. This condition was predominant at H8, H9, H10 and LF4.

2. About 80% of the elements had an 18 inch circular pattern of rust that had a rough raised surface similar to weld splatter 1/8 inch high.

3. The TRG strut had a flap of pliobond cement protruding from the joint where the strut and its end-cap meet. This flap

3.

extend 3/4 of an inch out. The paint on the bottom section of the strut was gone.

4. There was a full cover of grass on No. 1 and No. 2 (GD) Seachests. The hull had a 10% grass coverage. White lines and numbers varied in coverage from zero to 100%.

5. A light barnacle coverage existed on the aft end of TRG strut and the ships sonar dome.

6. The Sonar Dome was badly damaged on its bottom. This was previously reported.

C. All the following measurements taken are based on the ship being reasonably level in drydock. This was checked by clinometer readings on the bridge that indicated a list to port of  $1/2^\circ$  and the forward engine room clinometer read  $1/4^\circ$  (to port). A further check by sighting a plumb line down the bow indicated that the ship was sitting level. Complete measurements were not obtained due to shipyard conditions.

1. Dimension "Z" is the height above keel bottom to the lower edge of the element and dimension "Y" is the distance off the center-line to some point as dimension "Z". Angle "A" is the true angle of the transducer face off the vertical.

6

Element Number	Hydrophone Serial No.	Signal Pre-Amp Serial No.	Accel. Pre-Amp. Serial No.	DIM Z	DIM Y	Angle A
HF	1 P1007	110	---	--	--	58°
	2 P1011	117	256	--	--	57°
	3 P1076	253	160	--	--	57°
	4 P1036	121	---	--	--	56°
	5 P1027	146	---	2'-0"	2'-1 $\frac{1}{2}$ "	55°
	6 P1019	125	---	--	--	55°
	7 P1030	136	---	--	--	54°
	8 P1002	112	---	--	--	53°
	9 P1014	130	---	--	--	52 $\frac{1}{2}$ °
	10 P1060	137	---	--	--	70 $\frac{1}{2}$ °
	11 P1031	149	---	--	--	65°
	12 P1004	103	---	--	--	62°
	13 P1008	122	---	--	--	50°
G	1 P1095	144	---	--	--	61 $\frac{1}{2}$ °
	2 P1073	135	153	--	--	61 $\frac{1}{2}$ °
	3 P1021	131	132	--	--	--
	4 P1098	152	---	--	--	--
	5 P1020	141	151	--	--	--
	6 P1042	145	---	--	--	--
	7 *P1045	156	---	--	--	51 $\frac{1}{2}$ °
	8 P1071	143	164	--	--	15°
	9 P1079	155	140	--	--	66°
	10 *P1052	133	---	--	--	66 $\frac{1}{2}$ °

Element Number	Hydrophone Serial No.	Signal Pre-Amp Serial No.	Accel. Pre-Amp. Serial No.	DIM Z	DIM Y	Angle A
LF-1	P1015	111	116	0'-10"	2'-9 $\frac{1}{2}$ "	24 $\frac{1}{2}$ °
	2 P1034	259	258	---	---	24 $\frac{1}{2}$ °
	3 P1010	120	---	---	---	22°
	4 P1001	127	---	---	---	20 $\frac{1}{2}$ °
	5 P1043	113	---	0'-10 $\frac{1}{4}$ "	2'-11 $\frac{3}{8}$ "	19 $\frac{1}{2}$ °
	6 P1063	106	---	---	---	18 $\frac{1}{2}$ °
	7 P1029	150	---	---	---	17 $\frac{1}{2}$ °
	8 P1059	118	---	0'-2"	1'-2"	17 $\frac{1}{2}$ °
	9 P1068	142	---	4'-11 $\frac{1}{2}$ "	8'-10 $\frac{1}{2}$ "	---
	10 P1012	123	---	3'-8 $\frac{1}{2}$ "	7'-6"	---
	11 P1062	107	---	2'-6 $\frac{1}{2}$ "	6'-1"	35°
	12 P1050	102	---	1'-6"	4'-6 $\frac{1}{4}$ "	27 $\frac{1}{2}$ °
	13 P1065	134	---	0'-2 $\frac{3}{8}$ "	1'-1 $\frac{5}{8}$ "	18°
H-1	P1075	105	---	1'-1"	3'-0"	26 $\frac{1}{2}$ °
	2 P1051	148	---	---	---	26°
	3 P1078	126	---	---	---	21°
	4 P1057	159	---	---	---	12°
	5 P1046	158	---	0'-11"	5'-5"	13 $\frac{1}{2}$ °
	6 P1061	255	168	1'-8"	8'-8"	21°
	7 P1056	251	---	1'-10 $\frac{1}{2}$ "	9'-8 $\frac{1}{2}$ "	19°
	8 P1016	139	---	1'-9"	10'-0"	17°
	9 P1009	114	147	0'-6 $\frac{3}{4}$ "	5'-0"	11 $\frac{1}{2}$ °
	10 P1049	129	---	0'-1"	1'-3"	10°

2. Measurements of the rubber thickness at each element in the No. "1" (GD)Seachest obtained from R. Duerr (DTMB).

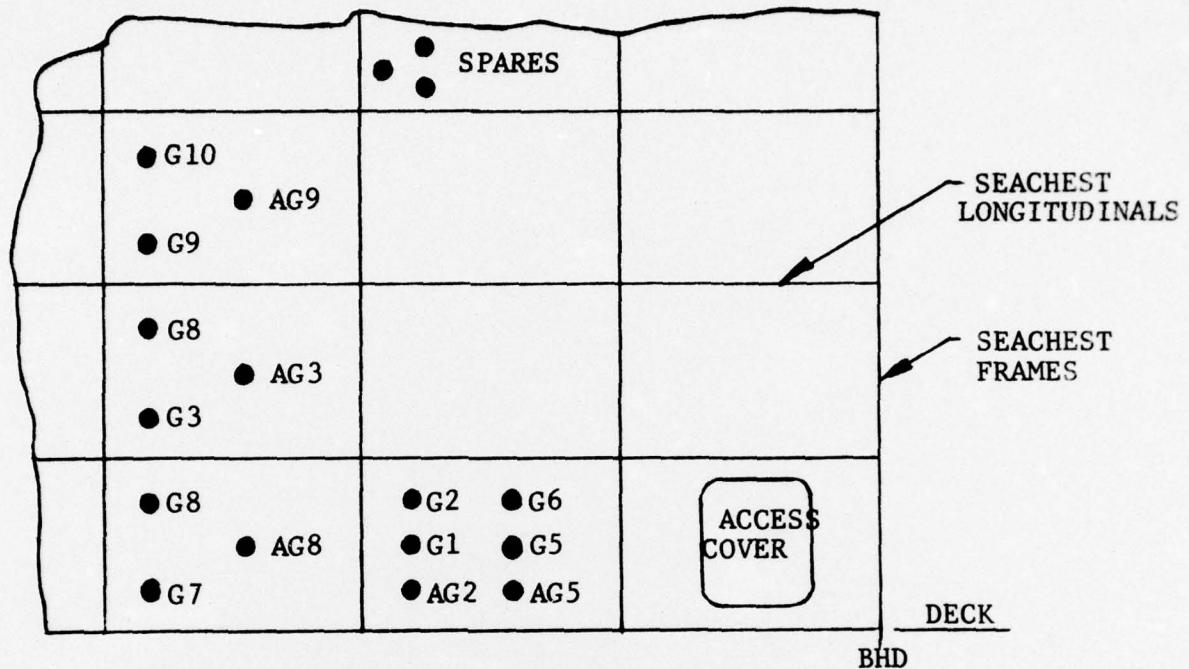
<u>Element No.</u>	<u>Nominal Thickness</u>	<u>Actual Thickness</u>
D1	9/16"	1 5/32"
D2	1 1/8"	1 47/64"
D3	2 1/4"	2 51/64"
D4	4 1/2"	4 59/64"
D5	1/4"	5/8"
D6	9/16"	13/16"
D7	1 1/8"	1 23/32"
D8	2 1/4"	2 25/32"
D9	4 1/2"	5 1/32"
D10	1/4"	59/64"

3. The Hydrophone (LC-57) in the sonar dome (T-1) was located 39 inches aft of leading edge of dome, 23 inches to port of center-line and 43 1/2 inches below keel bottom. The dome interface was 1 1/2 degrees off transversely.

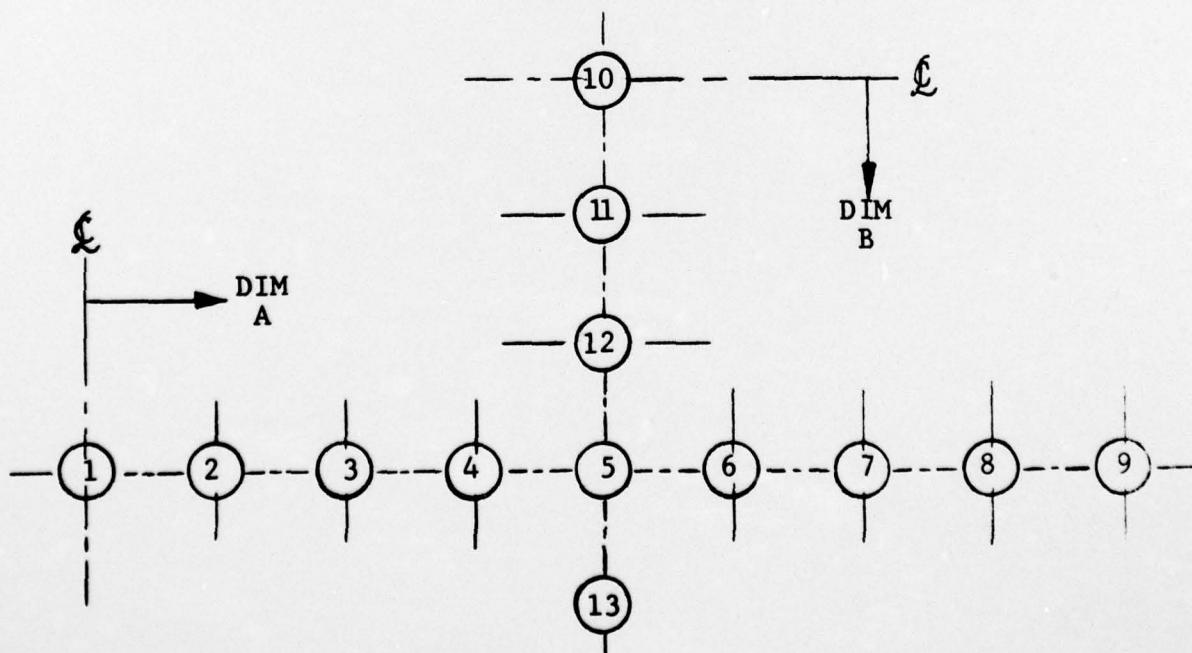
4. The overside calibration stations measured as follows:
- a) Dim Z is the height above keel to the base plate that the lower sleeve sits on.
  - b) Dim. Y is the distance off center-line of ship to the center-line of the sleeve.

<u>Calibration Station No.</u>	<u>DIM Z</u>	<u>DIM Y</u>	<u>Distance from Frame (Approx.)</u>
1	26'-7 $\frac{1}{2}$ "	11"-6"	6" Fwd. of Fr. 18
2	26'-3"	12'-10 $\frac{1}{2}$ "	6" Fwd. of Fr. 23
3	23'-7"	17'-6"	10" Fwd. of Fr. 49
4	22'-7 $\frac{1}{2}$ "	18'-2 $\frac{1}{4}$ "	
5	20'-10 $\frac{1}{2}$ "	19'-11"	10" Fwd. of Fr. 81

## 5. Stuffing tube locations in No. II window

INBOARD VIEW LOOKING OUT

Distances of element from reference line, measured along hull surface:



High Frequency Array

<u>ELEMENT</u>	<u>DIM A</u>	<u>DIM B</u>
HF 1	0 (REF DIM)	
2	0' - 11 $\frac{3}{4}$ "	2' - 11 $\frac{3}{8}$ "
3	1' - 9 $\frac{5}{8}$ "	" "
4	2' - 8 $\frac{5}{8}$ "	" "
5	3' - 6 $\frac{3}{4}$ "	2' - 11 $\frac{3}{8}$ "
6	4' - 6 $\frac{1}{8}$ "	" "
7	5' - 4 $\frac{1}{8}$ "	" "
8	6' - 3 $\frac{3}{8}$ "	" "
9	7' - 1 $\frac{1}{8}$ "	" "
10	3' - 6 $\frac{3}{4}$ "	0 (REF DIM)
11	" "	1' - 0"
12	" "	1' - 10 $\frac{1}{4}$ "
13	" "	4' - $\frac{1}{4}$ "

LOW FREQUENCY ARRAY

Horizontal Row Only.

<u>Element</u>	<u>DIM A</u>	
LF - 1	0 (REF DIM)	
2	2'-6"	
3	5'-3"	
STRUT	7'-9"	C.I.C. RETRACTABLE STRUT
4	10'-5 $\frac{3}{4}$ "	3' - $\frac{1}{4}$ " OFF C of SHIP
5	13'-0"	STRAIGHT LINE MEASUREMENT
6	15'-9 $\frac{1}{8}$ "	
7	18'-2 $\frac{3}{8}$ "	
8	20'-11 $\frac{3}{4}$ "	

The following is a measurement of transmission path giving the distance from the element to transmitter.

From (T-4) to H5 =	15'-9"
" " H6 =	11'-2"
" " H7 =	8'-7"
" " H8 =	13'-7"
" " H9 =	5'-1 $\frac{1}{2}$ "
" " H10 =	5'-1"

A check of the painted grid lines showed that their W.L. locations are not to print. A more extensive check could be accomplished by a three man team with aid of shipyard staging or ladders and proper measuring tools.

JHK:aek

Joseph H. Koestner

Distribution: W. Graham, W. Landauer, J. Kotik, A. Raff, G. Sammis,  
 R. Newman, N. Nesenoff, S. Gardner, I. Melnick,  
 C. Hackeling, H. Jennings, J. Koelbel.

## APPENDIX G

### REDUCTION OF FLOW NOISE BY A COVERING LAYER

We review briefly the basic points relevant to the question of noise reduction by a layer.\* At a given frequency, three contributions to the noise on a large flush element (radius  $R_o$ ,  $\omega R_o / U_\infty \gg \pi$ ) are distinguished. The first two are due directly to pressure fluctuations associated with the turbulent boundary layer (TBL). Of these, the first is a high-wave number part ( $K > \omega / U_\infty$ ) which is the only kind that would be present if the pressure were generated by "frozen" eddies convected downstream at velocities not exceeding the ship speed ( $U_\infty$ ). This part varies with radius as  $R_o^{-3}$ . Any additional pressure fluctuations due to surface roughnesses are expected also to be of this high-wavenumber character. The second is a low-wavenumber component ( $K \lesssim 2\pi R_o^{-1}$ ); the amplitude of this component is no doubt much smaller than that of the former, but it is more heavily weighted in the average pressure on the element, since its contribution is much less reduced by area averaging. The third contribution to noise is understood to include all other sources; it is presumed to have the character of a radiated sound field (modified by interaction with the flow-bounding hull and including any sound due to compressibility of the fluid of the TBL).

Shielding the given element by a layer of depth  $L$  is expected to have the following effects on the three contributions. The first (high wavenumber) part will be reduced to negligibility provided roughly  $L \gg U_\infty / \omega$  and the lateral dimensions of the layer are large compared to the element diameter (and perhaps larger than the wave length  $\lambda (= 2\pi c / \omega)$  of sound in the layer material. In some parameter regime, more specifically, this part is reduced

\*The explicit mathematical analysis that has been done pertains to a fluid, not a solid, layer. We expect, subject to experimental test, that an elastic solid behaves similarly provided the transverse sound velocity is of the order of the sound velocity for the fluid analog and large compared to the ship speed.

rather as though averaged, not over the element area, but over the lateral area of the layer. The second (low-wavenumber TBL) part will be reduced to an extent depending mainly on the ratios  $R_o/\lambda$  and  $R_o/L$ . For example, if the wavenumber spectrum of the TBL pressure at frequency  $\omega$  is constant\* in the range in question (whence this part of the average-pressure spectrum for the flush element would vary as  $R_o^{-2}$ ), this part for the shielded element is reduced as if averaged, not over the element area, but over an area  $\pi R_e^2$ , if  $R_e \gtrsim R_o$ , where:

$$R_e^{-2} = (\pi/\lambda)^2 + 1/8L^2$$

i.e., roughly over an area of radius equal to the smaller of three times the layer thickness or one third the sound wave length in the material; if  $R_e \lesssim R_o$ , however, (as becomes true at sufficiently high frequency) this part is not appreciably reduced. The third (radiative) part will not be substantially reduced for any  $L$ , except that if the material is such as to introduce an acoustic impedance mismatch with respect to the water outside, both a signal and this part of the noise will be reduced similarly (such mismatch is thus not desired).

The reductions of these contributions to the effective noise on an array (as opposed to a single element) depend also on their correlation properties and have been similarly analyzed. Some further discussion and numerical estimates for the type of array in question are contained in an appended section of a document generated at TRG in the ONR-supported flow-noise work.

For practical reasons it would be desirable that the covering layer not have to be integral across the periphery of the element face. If it is instead cut along this line, i.e., if the element has a boot (in addition to any it has for flush installation) and the adjacent hull has a separate contiguous boot

---

\* i.e., when averaged over wave-vector direction in the boundary, constant per unit area in two-dimensional wave-vector space.

of the same thickness, the noise reduction may well be much the same as for an integral layer, provided normal stresses are freely transmitted across the cut between boot edges. Possibly, adequate transmission of normal stress would occur even if the adjoining boots are not in contact, by virtue of the thin layer of water between them.

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B026-47011/47013

REFERENCES

1. TRG Document No. 023-TM-66-17 PURVIS I Sea Trials Data Acquisition and Analysis Equipment.
2. TRG Report No. 023-TN-66-20 Data Conversion System Description.
3. TRG Report No. 023-TM-66-19 (CONFIDENTIAL) Interim Report on PURVIS I Acoustic Tests (U)
4. D. Chase, TRG-011-TN-65-8 (23rd Navy Symposium on Underwater Acoustics, Washington, D.C., 1965)

**UNCLASSIFIED**

R-1